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POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 34
Main Document

December 2000

Water Policy Program
International Resources Group   Winrock International   Nile Consultants

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Main Document

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Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)
Partners: *International Resources Group, Winrock International,*
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Appendix 1	Wastewater Treatment in Egypt By Eng. Magda Gaballa and Eng. Mamdouh Mohsen of NOPWASD
Appendix 2	Health Impact and Water Quality Standards in Wastewater Irrigation By Dr. Sehem Hendi of MOHP
Appendix 3	Wastewater Irrigation for Forest Plantation By Dr. Mamdouh Riad of MALR
Appendix 4	Industrial Wastewater Management By Dr. Ahmed Gamal Eldin of EEAA
Appendix 5	Wastewater Effluents Administration and Management By Eng. Yahia Abdel Aziz of MWRI
Appendix 6	Priorities for Improving Drainage Water Quality in the Delta By Dr. Ahmed Fakhry Khattab of EPIQ and Dr. Hesham Kandil of MWRI

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1. Table of Contents

ACRONYMS AND ABBREVIATIONS

AGOSD	Alexandria General Organization for Sanitary Drainage
APRP	Agricultural Policy Reform Program
BCM	Billion Cubic Meters
BOD	Biological Oxygen Demand
CGOSD	Cairo General Organization for Sanitary Drainage
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
EEAA	Egyptian Environmental Affairs Agency
GOE	Government of Egypt
M&I	Municipal and industrial
MALR	Ministry of Agriculture and Land Reclamation
MCM	Million Cubic Meters
MOHP	Ministry of Health and Population
MHUUC	Ministry of Housing, Utility, and Urban Communities
MWRI	Ministry of Water Resources and Irrigation
NOPWASD	National Organization for Potable Water and Sanitary Drainage
O&M	Operations and Maintenance
USAID	United States Agency for International Development
TDS	Total Dissolved Solid
WHO	World Health Organization
WPAU	Water Policy Advisory Unit
WWTP	Wastewater Treatment Plant

Executive Summary

Introduction

The purpose of this document and the six appendices is to present the results of the work carried out under Benchmark C2 of the Memorandum of Understanding between the Arab Republic of Egypt (GOE) and USAID/Egypt for the APRP Tranche IV (1 July 1999 – 31 December 2000).

The benchmark states:

> *The GOE (MWRI) will adopt policies for improved management of discharge and reuse of urban wastewater in agricultural drains.*

The verification indicator is:

> *The MWRI will approve a policy and procedures for managing and reusing urban wastewater discharges in agricultural drains and submit them to the Cabinet by 31 December 2000.*

Benchmark Activities

Accomplishing the benchmark requires the active involvement of several ministries and agencies. Participation, cooperation, and consistent policy development from all involved ministries were targeted from the very beginning of the benchmark design. A principle element in benchmark activity design is the contribution from each party's experience and wisdom for a commonly agreed policy. An APRP/MWRI Wastewater Task Group was organized with representatives from the following five ministries and agencies:

- Ministry of Water Resources and Irrigation (MWRI)
- Ministry of Agriculture and Land Reclamation (MALR)
- Ministry of Health and Population (MOHP)
- National Organization of Potable Water and Sanitary Drainage (NOPWASD) of the Ministry of Housing, Utilities, and Urban Communities (MHUUC)
- Egyptian Environmental Affairs Agency (EEAA)

Under the benchmark, the following major activities were conducted during the period from 1 July 1999 – 31 December 2000:

- Established a conceptual framework, including identification of critical areas of urban wastewater management, to guide policy development.
- Organized an APRP/MWRI Wastewater Task Group to carry out benchmark activities. The group, composed of eight representatives from the five cooperating ministries and agencies, routinely met every 2-3 weeks, and organized four workshops to discuss policies and monitor benchmark activities.

- Conducted, for the first time in Egypt, a sampling program for the water microbial features in Salaam Canal, its feeding drains, and the effluents of the Mansoura wastewater treatment plant.
- Participated in a MOHP-WHO sponsored wastewater irrigation training to promote public awareness.
- Conducted international study tours to Jordan (a neighboring country with an equivalent economic development level) and California, USA (renown for its stringent water quality standards and the most advanced wastewater treatment technology) to gain from their wastewater management experiences.
- Organized inter-ministry policy development by providing each party with policy outlines and technical discussions. Appendices 1-6 are the representatives' reports from each cooperating ministry or agency.

This Summary Policy Document report presents conclusions reached by, and recommended policies of, the APRP/MWRI Wastewater Task Group.

Recommended Policies and Procedures

The Delta region (including Greater Cairo) has an estimated population of 45 million and generates more than 2 billion cubic meters of wastewater per year. A majority portion of this large volume is from cities and towns. Agricultural drains receive all types of wastewater and experience more severe contamination than the Nile River and canals. However, agricultural drainage is part of the irrigation source in the Delta. The management of wastewater discharge and reuse should receive priority consideration in Egypt's water pollution control.

Wastewater enters the large-scale Nile irrigation system by two mixing processes: to mix with agricultural drainage in drains, and to mix with freshwater in canals. These two mixing processes disperse pollution and degrade the water quality of the entire irrigation system. A fundamental impetus for remedial policy development is to minimize the wastewater entrance at these two mixing processes.

Treatment is fundamental and ultimate to wastewater management. However, full treatment of wastewater in the Delta is far from reality, given the nation's economic development level. Even in those constructed treatment plants, operations are inefficient, and the environmental improvements from plant operations are not strongly evident.

The general Nile irrigation is an unrestricted irrigation. Canal water, after being mixed with drainage water, is used without crop restrictions. The unrestricted irrigation system is vulnerable from the intrusion of wastewater. Given the fact that an alternative to drains as sewage dumping sites is impossible in the Delta, a central need is to exhaust the wastewater in restricted uses so that its effect on the general Nile irrigation system can be minimized.

Restricted uses of wastewater are not well developed in Egypt. However, the wastewater irrigation on timber trees in the deserts conducted by the Afforestation Department of MALR has proven feasible and promising. A direct benefit is the reduction of unwanted wastewater in the general Nile irrigation system.

Law 48 is the governing law for water quality management in Egypt. Law 48 sets specific water quality standards in Articles 65 and 66 for the two mixing processes in addition to Articles 60-64 for general waste discharge in canals. Although Law 48 has no specifications on intestinal nematode eggs - the major threats to human health from wastewater, the pioneer legislators recognized the importance of the two mixing processes in Egyptian water quality management. The 1989 World Health Organization Guidelines and the newly issued Ministerial Decree 44/2000 (by the Ministry of Housing, Utility, and Urban Communities) distinguish the water quality requirements for unrestricted and restricted irrigation. However, compliance with these water quality standards remains to be implemented.

The management of urban wastewater involves many stakeholders including government ministries and the private sector. There are outstanding issues and questions concerning authority, responsibility and cooperation among these stakeholders.

The benchmark task group has recommended the following policies and procedures for improved urban wastewater management.

1) Treatment of Wastewater

Policy #1 ***In wastewater treatment plant construction, the territorial equity rationale must be replaced by a broader national interest. The criteria for prioritizing the construction of wastewater treatment plants should be:***

- ***To protect human health (mainly drinking water sources);***
- ***To sustain agricultural drainage reuse; and***
- ***To maintain ecological balance in lakes and on seashores.***

Procedures *NOPWASD, together with MWRI, MOHP, and EEAA, should prepare a prioritized construction and implementation plan for wastewater treatment plants for the period 2000-2007, based upon the above mentioned priority criteria, available budget, and current on-going construction activities.*

Policy #2 ***An urgent need in wastewater treatment is to improve the effectiveness of those treatment plants already constructed and operational.***

Procedures *NOPWASD should create more educational and practical opportunities for the development of Egyptian wastewater treatment professionals. WWTP operation codes, operator license system, and effluent quality control must be enforced. The corporation model of the Public Economic Authority, as a transition to full privatization of wastewater services, should be extended to more governorates, and a user-pays, self-reliant finance mechanism must be exercised in those authorities. NOPWASD should also strengthen public awareness education about urban wastewater services.*

Policy #3 ***Minimize the discharge of industrial wastewater to municipal sewers and agricultural drains. Agricultural drains are not open dumping sites for***

industrial wastes, and pre-treatment of industrial toxic wastes at the source is a must.

Procedures *EEAA should extend its effort of restricting industrial waste dumping in the Nile River to the agricultural drains and city sanitary sewers. New industries, either large or small, must meet the at-source treatment requirements for permitted operation. MWRI, in cooperation with EEAA and MOHP, should establish more restrictions on industrial wastewater discharge in agricultural drains.*

2) Health Concerns and Wastewater Quality Standards

Policy #4 ***The primary threats of wastewater irrigation to human health are pathogenic organisms found in wastewater including bacteria, viruses, protozoa, and helminthes.***

Procedures *MOHP, in cooperation with MWRI and NOPWASD, should strengthen public awareness education on the human health risks of wastewater irrigation. All cooperating ministries should establish a better understanding of the various potential mitigating measures and their applications under the Egyptian conditions. MOHP should increase its scientific research to examine human health risks from wastewater irrigation in the Egypt. NOPWASD should pay more attention to the effective removal of pathogens in treatment plants.*

Policy #5 ***The water quality requirements issued in Law 48 and MHUUC Ministerial Decree No 44/2000 represent the authorized standards in Egypt. All involved ministries and agencies should better recognize the role of MOHP in wastewater quality inspection and regulatory development.***

Procedures *MOHP should accelerate technical capacity building at both national and local levels for the increasingly complicated quality monitoring and inspection tasks. MWRI should classify the Nile watercourses for different water quality standard applications. MOHP, in cooperation with MWRI and other involved ministries, should develop clear responsibility lines in monitoring wastewater treatment plants, mixing points in drains and canals, lakes and seashores, unrestricted and restricted irrigation fields, and other sites of particular interest.*

3) Discharge and Reuse of Wastewater

Policy #6 ***Separation of wastewater from agricultural drains is critical to sustain general irrigation in the Delta. Efforts in this direction, including drain function classification, intermediate drainage reuse, and wastewater tree-irrigation in the desert, should be recognized and supported.***

Procedures *MWRI, in cooperation with NOPWASD, MOHP, and local municipal authorities, should organize an overall drain classification program for the Delta. MWRI, in cooperation with local municipal authorities, should assess and implement, in steps, necessary penalties for discharging untreated* *wastewater into classified reuse drains and using drain water from classified discharge drains.*

Policy #7 ***The MWRI drainage-monitoring program has functioned as a main technical support in Delta region's water quality management during the past two decades. The program should be encouraged and continued.***

Procedures *MWRI, in cooperation with MOHP and EEAA, should upgrade the existing drainage monitoring program for more competent wastewater-related monitoring work.*

Policy #8 ***Follow the MHUUC Ministerial Decree 44/2000 and WHO 1989 Guidelines to initiate restricted irrigation for the safe use of wastewater on selected crops.***

Procedures *MALR, in cooperation with MWRI and MOHP, should plan crop zones for different quality irrigation sources in the Delta. MALR and MWRI should test pure wastewater irrigation for selected crops with cautious assessment of the possible groundwater contamination in neighboring areas.*

Policy #9 ***Wastewater effluent irrigation on timber trees in the desert is an environmentally and economically sound reuse. The effort should be recognized, encouraged, and supported.***

Procedures *MALR should expand its current effort to promote wastewater irrigation of timber trees in the desert by strengthening public awareness education programs and by providing stronger economic incentives to attract private sector participation. MALR and MWRI should better cooperate to conduct environmental impact assessment, particularly groundwater impact evaluation, for wastewater irrigation in timber tree plantation.*

Policy #10 ***Use wastewater effluents to grow green lands in cities and towns in the Delta.***

Procedures *The Afforestation Department of MALR, in cooperation with MWRI and Dakhalia Governorate, should conduct a pilot program using wastewater effluents to grow street trees in Mansoura City. The pilot work should include an environmental impact assessment.*

4) Inter-ministry Cooperation

Policy #11 ***Inter-ministry cooperation is the foundation of the urban wastewater management endeavor. MWRI, as the national water authority, has to take the lead in developing and sustaining the cooperation.***

Procedures *Establish a commonly agreed cooperation framework, clarify each party's authority and obligation lines, and establish a financial mechanism to support cooperation in water quality management.*

1. Introduction

1.1 Overview

The Agricultural Policy Reform Program (APRP) is a six-year United States Agency for International Development (USAID) grant program involving several ministries. The Ministry of Water Resources and Irrigation (MWRI) is the primary Egyptian governmental agency charged with the management of water resources. MWRI and USAID, under the umbrella of the APRP, jointly designed a water policy package, which consists of integrated water policy and institutional reforms. USAID supports the Ministry's efforts through annual cash transfers based on performance in achieving identified and agreed upon policy reform benchmarks and technical assistance.

Co-ordination among MWRI, USAID, and the water policy technical assistance program is through the Water Policy Advisory Unit (WPAU) and a project steering committee established by the MWRI. Technical assistance for the water policy analysis activity is provided through a water resources results package task order (Contract PCE-I-00-96-00002-00, Task Order 807) under the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (APRP/MWRI) between USAID and a consortium headed by the International Resources Group (IRG) and Winrock International. Local technical assistance and administrative support is provided through a subcontract with Nile Consultants.

1.2 Purpose of the Report

A Memorandum of Understanding between the Arab Republic of Egypt and USAID, dated 20 September 1999, listed the mutually agreed policy reform benchmarks for the APRP Tranche IV period (1 July 1999 – 31 December 2000). Benchmark C2, Urban Wastewater Discharge and Reuse, states:

> ***The GOE (MWRI) will adopt policies for improved management of discharge and reuse of urban wastewater in agricultural drains.***

The implementation of this benchmark extends into two years. Satisfactory achievement of the benchmark requires the accomplishment of the following two verification indicators:

1) *The MWRI will approve a policy and procedures for managing and reusing urban wastewater discharges in agricultural drains and submit them to the Cabinet by 31 December 2000.*
2) *The MWRI in coordination with other ministries and authorities will apply the policy and procedures in one selected pilot area in the Delta by 31 December 2001.*

The purpose of this report, including its six appendices, is to address the first verification indicator by presenting the proposed policies and procedures for the management of urban wastewater discharge and reuse.

1.3 Background

With rapid population growth and industrialization over the past decades, the Nile River and its canals and drains, particularly the drains in the Delta, have become contaminated, as indicated by consistently high fecal coliform levels and the closed operation of several main drainage reuse pump stations. Serious policy actions to combat water pollution caused by wastewater discharge and prevent further degradation of the Delta's water environment are urgently needed.

The Delta region (including Greater Cairo) has an estimated population of 45 million and generates more than 2 billion cubic meters of wastewater per year. A majority portion of this large volume is from cities and towns. Among the identified main pollutants (pathogens, heavy metals, pesticides, and salinity) in the Delta's water environment, pathogens are the most harmful. Pathogens mainly originate in urban sewage and pose significant human health and agricultural production problems. Drains in the Delta receive all types of wastewater and experience more severe water contamination than the Nile River and canals. However, drain water is reused as part of the irrigation source in Egypt, a practice that will continue in the future. The management of sewage discharge, particularly the large volume and concentrated urban sewage discharge in Delta agricultural drains, should receive priority consideration in Egypt's water pollution control efforts.

The treatment of urban wastewater is practiced in Egypt. Nevertheless, there are gaps between the available treatment capacity and the demands for treatment; full treatment of urban wastewater will not be possible soon. There is also a problem of prioritizing the locations and treatment levels of urban wastewater so that they can better support the MWRI drainage reuse policy. Even for treated effluents, there is a question of how best to use them for improving environmental quality and supplying agricultural irrigation.

There are three major issues related to urban wastewater discharges:

- Pollution in the Nile system, particularly in agricultural drains in the Delta, poses increasing risks to human health and agricultural sustainability. Without action, the region's prosperity will deteriorate.
- Large volume and concentrated discharges of urban wastewater in agricultural drains increasingly threaten the sustainability of drainage reuse in the Delta.
- Pollution consumes large amount of usable drainage in the Delta.

Water quality is an essential component of Egypt's water management; however, it has not been adequately addressed. The APRP Tranche III Benchmark C8 (Law 48 Amendment) represented one of the efforts to address water quality issues within a policy and legislation framework. The benchmark recommended a compliance action plan for pollution abatement. One important component of that plan is the management of wastewater discharge in agricultural drains.

This benchmark, as a continuing effort of the Tranche III Benchmark C8, will establish integrated policies and procedures for managing urban sewage discharge. The objectives of the benchmark are to:

- Establish an integrated policy for handling urban sewage disposal and reuse;

- Enhance compliance with the objectives and targets of Law 48; and
- Promote coordination and implementation between MWRI and other ministries in water pollution control and environmental quality management.

Anticipated effects for this benchmark include:

- Integration of MWRI strategies for discharging and reusing urban wastewater;
- Enhancement of MWRI capabilities in managing urban sewage disposal; and
- Improvement of inter-ministry coordination in urban wastewater disposal and reuse.

1.4 Benchmark Activities

The benchmark has a two-stage implementation plan: Phase I (November 1999 – December 2000) to develop policies and accompanying procedures, and Phase II (December 2000 – December 2001) to test and modify the policies and procedures. Accomplishing the benchmark requires the active involvement of several ministries and agencies. Participation, cooperation, and consistent policy development from all involved ministries were targeted from the very beginning of the benchmark design. A principle element in benchmark activity design is the contribution from each party's experience and wisdom for a commonly agreed policy. An APRP/MWRI Wastewater Task Group was organized with representatives from the following five ministries and agencies:

- Ministry of Water Resources and Irrigation (MWRI)
- Ministry of Agriculture and Land Reclamation (MALR)
- Ministry of Health and Population (MOHP)
- National Organization of Potable Water and Sanitary Drainage (NOPWASD) of the Ministry of Housing, Utilities, and Urban Communities (MHUUC)
- Egyptian Environmental Affairs Agency (EEAA)

Under the benchmark, the following major activities were conducted:

- Established a conceptual framework, including the identified critical areas of urban wastewater management, to guide the policy development.

- Organized an APRP/MWRI Wastewater Task Group to carry out benchmark activities. The group, composed of eight representatives from the five cooperative ministries and agencies, routinely met every 2-3 weeks, and organized four workshops to discuss policies and monitor benchmark activities.

- Conducted, for the first time in Egypt, a sampling program for the water microbial features in Salaam Canal, its feeding drains, and the effluents of the Mansoura wastewater treatment plant.

- Participated in a MOHP-WHO sponsored wastewater irrigation training to promote public awareness.

- Conducted international study tours to Jordan (a neighboring country with an equivalent economic development level) and California, USA (renown for its stringent water quality standards and the most advanced wastewater treatment technology) to gain from their wastewater management experiences.

- Organized inter-ministry policy development by providing each party with policy outlines and technical discussions. Appendices 1-6 are the representatives' reports from each cooperating ministry or agency. This document summarizes the recommended policies and procedures on behalf of the APRP/MWRI Wastewater Task Group.

1.5 Organization of the Report

Chapter 1 provides the background, identifies the participating parties, and summarizes the major activities that have been conducted under this benchmark. Chapter 2 describes the general situation of wastewater discharge and reuse in the Nile Delta, and identifies the critical issues to be addressed in this document. Chapter 3 presents the development status and performance levels of wastewater treatment plants, and recommends two policies with accompanying procedures for improvement. The chapter also provides one policy recommendation for improved industrial wastewater treatment at the source. Chapter 4 reviews health concerns associated with wastewater irrigation, provides a brief development history of wastewater quality standards, and suggests three policies and accompanying procedures for improved wastewater effluent quality control and drainage quality monitoring. The chapter also, for the first time, publishes the sampling results of Salaam Canal's water microbial features. Chapter 5 addresses the reuse of wastewater and recommends four reuse policies and accompanying procedures. Chapter 6 presents a policy and accompanying procedures for improved inter-ministry cooperation in urban wastewater management. Chapter 7 presents the conclusions.

This document includes the following six appendices:

Appendix 1	Wastewater Treatment in Egypt (by NOPWASD representatives)
Appendix 2	Health Impact and Water Quality Standards in Wastewater Irrigation (by MOHP representative)
Appendix 3	Wastewater Irrigation for Forest Plantation (by MALR representative)
Appendix 4	Industrial Wastewater Management (by EEAA representative)
Appendix 5	Wastewater Effluents Administration and Management (by MWRI representative)
Appendix 6	Priorities for Improving Drainage Water Quality in the Delta (by MWRI representatives)

2. Existing Wastewater Discharge and Reuse

The discharge of wastewater, particularly the large volume of concentrated urban sewage, in agricultural drains poses an increasing pressure on water quality in the Delta. Since construction of the High Aswan Dam, the seasonal Nile floods, which frequently flushed the Delta's low lands, no longer reach the region and pollutants carried by wastewater have accumulated in the drain system. This was reflected by the sudden appearance of drainage contamination problems in the early 1990s when six out of the 26 main drainage reuse pump stations were forced to shut down periodically due to unacceptably poor drain water quality. Today, an amount of 2 - 3 billion cubic meters of agricultural drainage water is lost per year due to the discharge of wastewater. Obviously, Egypt cannot afford a loss of this magnitude in the future.

2.1 Discharge and Reuse Patterns in the Delta

Figure 1 below shows the existing wastewater discharge and reuse patterns in the Delta. The types of reuse squared by dotted lines are not available in the current system. They are needed and will be discussed and recommended in later chapters.

Two Mixing Processes

As shown in Figure 1, wastewater effluents enter the Nile irrigation system by two mixing processes: to mix with agricultural drainage in drains (MIX-1), and to mix with freshwater in canals as part of the drain water (MIX-2). Each mixing disperses the pollutants carried by wastewater to a larger water body and degrades the water quality of the entire system. Untreated sewage in drains also has the chance to intrude into the irrigation system through drainage reuse. These two mixing processes will continue to involve water quality problems unless wastewater is disposed of at destinations other than drains, which is impractical in the Delta.

Wastewater Treatment

Treatment is fundamental and ultimate to wastewater management. If all the wastewater could be satisfactorily treated before dumping into drains, there would be no water quality problem in the rest of the water cycle. However, full treatment of wastewater is not possible in the near future, given the nation's economic development level. Even in existing plants, operations are inefficient, and the environmental improvements from their operations are not strongly evident.

Unrestricted Irrigation System

The Nile irrigation system delivers water for unrestricted irrigation use. Fresh Nile River water and canal water, after being mixed with drainage water, is used without crop restrictions. Such unrestricted irrigation makes operation and management easier, but the system is vulnerable from wastewater effluents. Maintaining uniformly high water quality for unrestricted irrigation and increasing the use of wastewater effluents and other low quality water in the same system are conflicting goals. A central question is how to minimize the wastewater entering the unrestricted irrigation system by diverting the wastewater for use in other systems.

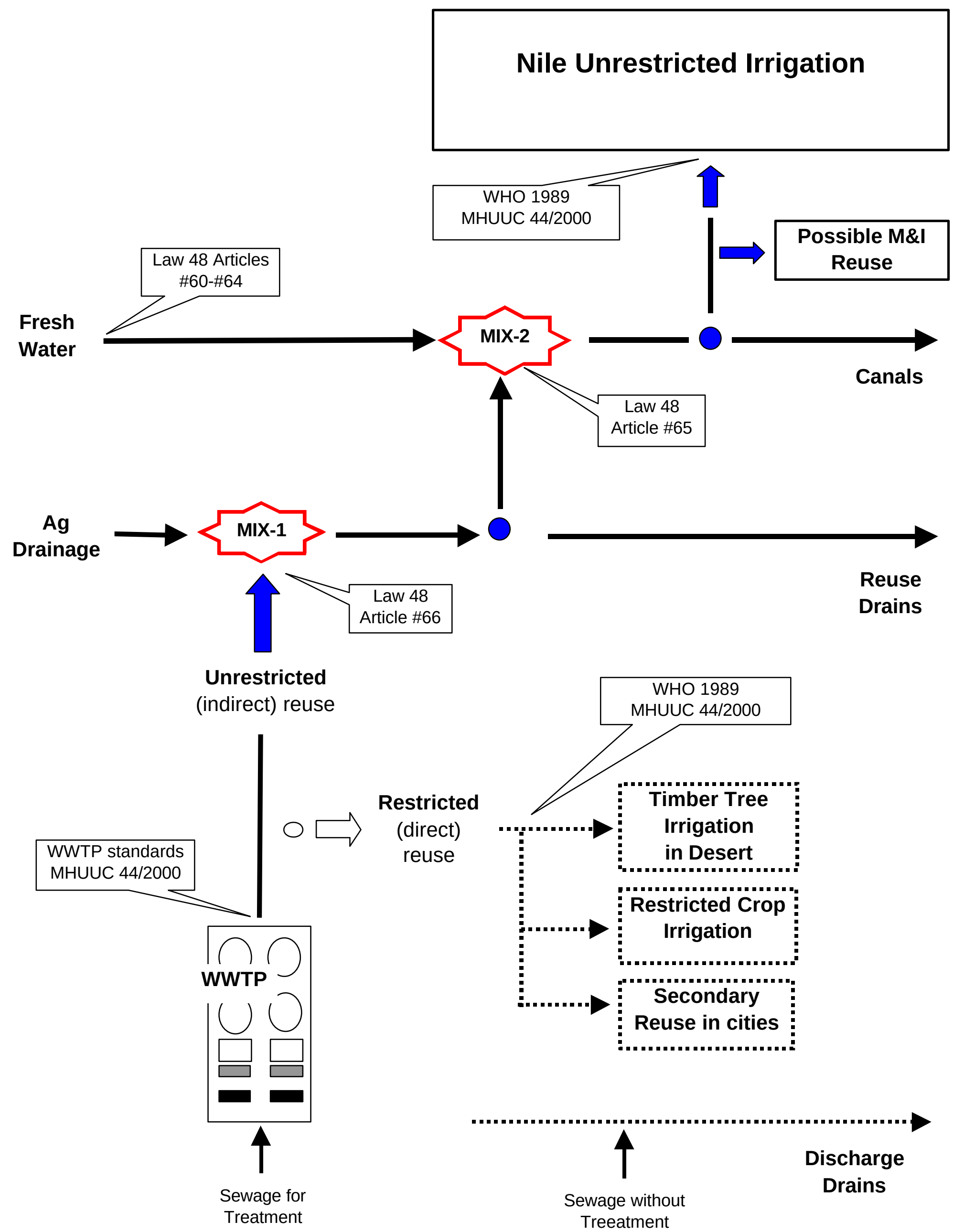

Figure 1, Discharge and Reuse of Urban Wastewater in the Delta

Intruded wastewater components (not toxic industrial waste) in the Nile irrigation system are likely after diluting several times and possibly after several days of detention in the drains and canals. This indirect reuse is different from the direct wastewater irrigation cited in international literature. Similar to natural river systems, biological assimilation occurs in the extended canals and drains in the Delta. This fundamental fact shouldn't be overlooked when assessing Egypt's wastewater discharge and reuse.

Restricted Wastewater Reuses

Restricted wastewater reuse is not well developed in Egypt. As indicated in Figure 1, they could include:

- Irrigating timber trees in the deserts;
- Irrigating crops tolerable to the quality of wastewater effluents; and
- Irrigating green lands in the cities.

The pilot programs of wastewater tree irrigation in the desert conducted by the Afforestation Department of MALR, have proven feasible and promising. The benefits of the timber-tree irrigation are multi-fold, but the primary benefit is that it provides an effective way to exhaust the unwanted wastewater entering the unrestricted irrigation system.

Laws, Regulations, and Standards

Law 48 is the main governing law for water quality management in Egypt. Law 48 sets specific water quality standards in Articles 66 and 65 for the mixing points MIX-1 and MIX-2 respectively, in addition to Articles 60-64 for general waste discharge in canals (Figure 1). Although Law 48 does not specify standards on intestinal nematode eggs - the major threats to human health from wastewater, the pioneer legislators did recognize the importance of the two mixing processes in Egyptian water quality management. Both WHO 1989 Guidelines and the newly issued MHUUC Ministerial Decree 44/2000 distinguish water quality requirements for unrestricted and restricted irrigation. However, some parts of the two standards seem overly restrictive in the Nile context. Compliance with these laws, regulations, and water quality standards remains to be implemented.

Inter-ministry Cooperation

The management of urban wastewater involves many stakeholders including government ministries and the private sector. There are outstanding issues and questions concerning authority, responsibility and cooperation among these stakeholders.

2.2 Identified Critical Issues

The APRP/MWRI Wastewater Task Group has identified the following critical issues for improved management of urban wastewater discharge and reuse:

Wastewater Treatment

- Prioritization of plant construction at given budget levels.
- Making existing treatment facilities function effectively.
- Treating industrial wastewater at sources.

Health Concerns and Wastewater Quality Standards

- Recognizing pathogenic threats to human health in wastewater irrigation.

- Understanding wastewater quality standards, MHUUC Ministerial Decree 44/2000, and MOHP role in wastewater quality inspection and regulatory development.

- Assessing the water quality status of the Salaam Canal.

Discharge and Reuse of Wastewater Effluents

- Separating untreated sewage flows from reuse drains.
- Continuing MWRI effort in drainage quality monitoring.
- Opening restricted irrigation on selected crops.
- Using wastewater effluents to grow timber trees in desert areas.
- Encouraging secondary wastewater reuse in cities.

Inter-ministry Cooperation

- Establishing a cooperation framework including division of responsibilities and financial mechanisms for cooperation.

3. Wastewater Treatment

The Government of Egypt has made major achievements in constructing municipal wastewater treatment plants in the past two decades. Currently, sewage treatment plants serve 55% of the population in towns and cities. Table 1 lists the operating wastewater treatment plants in the year 2000. There are 59 primary or secondary treatment plants operating with a total capacity of 6.2 mcm/day (or 2.3 bcm/year); of these plants, 52 plants with a capacity of 2.7 mcm/day were constructed under NOPWASD management, and the remaining seven were constructed under CGOSD and AGOSD management.

Table 1. Operating Wastewater Treatment Plants in Year 2000

	Governorates or Cities	Number of Plants	Operating Capacities (1,000 m^3/day)
1	**Damiatta**	3	127
2	**Daquahlia**	3	138
3	**Sharquia**	4	130
4	**Qalubia**	4	188
5	**Kafr ElSheikh**	1	19
6	**El Gharbia**	3	161
7	**El Beheira**	5	88
8	**El Monufia**	4	104
9	**Matrouh**	1	25
10	**Port Said**	1	190
11	**El Ismailia**	1	90
12	**El Suez**	1	130
13	**El Giza**	3	900
14	**El Fayoum**	1	40
15	**Beni Suief**	1	10
16	**El Menia**	2	60
17	**Assyout**	2	60
18	**Sohag**	1	22
19	**Qena**	1	30
20	**Luxor**	1	26
21	**Aswan**	1	21
22	**Greater Cairo**[1]	5	3,230
23	**Alexandria**[1]	2	317
24	**North of Sinai**	1	50
25	**South of Sinai**	5	31
26	**New Valley**	2	22
		59	**6,209** (2.27 bcm / year)

Note: 1) 5 plants in Cairo under GCGOSD, 2 plants in Alexandria under AGOSD, and another 52 plants at 2.662 mcm/day under NOPWASD.

2) Data source: Table 1 in Appendix 1.

3.1 Plant Construction Priorities

NOPWASD has a plan to achieve a daily treatment capacity of 4.7 mcm by the end of year 2007, as indicated in Table 2, Appendix 1. During 2000, a total capacity of 2.7 mcm/day was realized. The remaining capacity of 2 mcm/day targeted for operation by 2007 is equivalent to building 20 plants with an average capacity of 100,000 mcm/day (or 100 plants with an average capacity of 20,000 mcm/day) over the next seven years. Is this target achievable?

According to NOPWASD (Table 2, Appendix 1), an amount of LE 9.1 billion was spent to construct the current operating capacity of 2.7 mcm/day. Therefore, construction of an additional 2.0 mcm/day capacity would require approximately LE 6.7 billion. Over a seven-year period, this would entail an average annual investment of nearly LE 1 billion, assuming costs do not escalate. Table 2 below includes the actually allocated budgets to the wastewater sector during the past eight years. Higher budgets were allocated during the late 1990s. The average annual budget was approximately LE 1.3 billion. Financially, the plan seems achievable if the 1990s annual budget scale were continued in the coming seven years.

Table 2. NOPWASD Investments in Wastewater Treatment

Year	Actual Investments (million LE)
1992-1993	392
1993-1994	684
1994-1995	960
1995-1996	1,300
1996-1997	2,428
1997-1998	1,559
1998-1999	1,616
1999-2000	1,524
Total	**10,464**
Average Annual	**1,308**

Note: The 1996-1997 figure includes USAID funds on Canal Cities Projects.

However, the plan is not necessarily a construction completion schedule. Past construction history shows that the annual budget was first used for opening new projects instead of completing on-going constructions. A project could take 3 to 5 years longer to complete than scheduled. The rationale behind this construction approach was to spread the budget to as many projects as possible for territorial equity reasons. Governorates attempt to include every locally demanded project, urgently needed or not, in the NOPWASD plan. NOPWASD is not in a position to reject these governorate demands.

This territorial equity driven construction rationale should be replaced by a prioritized national plan for improved environmental and drain water quality. Under this benchmark, NOPWASD and MWRI representatives exercised their construction priority lists, as shown in Appendix 1 and Appendix 6, respectively. However, the two appendices used different criteria to sort preferences, which resulted in two different lists. The lists more accurately convey overall plans than prioritized lists for a given time period and financial budget. Construction priority issues need to be agreed to by both NOPWASD and MWRI.

Policy #1 ***In wastewater treatment plant construction, the territorial equity rationale must be replaced by a broader national interest. The criteria for prioritizing the construction of wastewater treatment plants should be:***

- ***To protect human health (mainly drinking water sources);***
- ***To sustain agricultural drainage reuse; and***
- ***To maintain ecological balance in lakes and on seashores.***

Procedures *NOPWASD, together with MWRI, MOHP, and EEAA, should prepare a prioritized construction and implementation plan for wastewater treatment plants for the period 2000-2007, based upon the above mentioned priority criteria, available budget, and current on-going construction activities.*

3.2 Performance of Constructed Plants

Egypt currently has 59 operating wastewater treatment plants, compared to 26 plants in 1982. However, the drain water quality improvement from these treatment plants is not strongly evident. One reason is that many of the plants are operating at a lower performance level than designed.

Primary causes for the low performance include:
- Non-skilled plant operators;
- Inadequate O&M budgets;
- Lack of spare parts;
- Over-flow without treatment;
- Insufficient use of chlorine disinfecting; and
- Lack of effluent quality control.

Even with the low performance, the O&M costs of these treatment plants represent a financial burden to the GOE. With the construction of more treatment plants in the next 5-7 years, the financial requirements will increase. Therefore, effective expenditures for wastewater treatment plant operations should be of major concern.

Policy #2 ***A urgent need in wastewater treatment is to improve the effectiveness of those treatment plants already constructed and operational.***

Procedures *NOPWASD should create more educational and practical opportunities for the development of Egyptian wastewater treatment professionals. WWTP operation codes, operator license system, and effluent quality control must be enforced. The corporation model of the Public Economic Authority, as a transition to full privatization of wastewater services, should be extended to more governorates, and a user-pays, self-reliant finance mechanism must be exercised in those authorities. NOPWASD should also strengthen public awareness education about urban wastewater services.*

3.3 Industrial Wastewater Treatment

Industrial wastewater, as part of the wastewater generated in urbanized areas, is often mixed with domestic wastewater in sewers or directly discharged to drains without pre-treatment in the Delta. Chemical components of industrial wastes are toxic to the bacteria needed in activated sludge treatment processes. Untreated industrial wastewater destroys the normal operation of biological treatment processes. This has occurred in the Shoubra Kheima treatment plant, where raw industrial waste from the region's numerous small industries impact the effectiveness of the activated sludge treatment processes.

The quantity and characteristics of industrial wastewater generated in the Delta region was not available to the Wastewater Task Group. But for the area neighboring the Salaam Canal, described in Appendix 5, the industrial wastewater discharged to the Hadous and Serw drains (the two feeding drains to Salaam Canal) accounts for 123 mcm/year and 47 mcm/year, respectively.

The newly issued MHUUC Ministerial Decree 44/2000 sets quality standards for industrial and commercial wastewater discharge into public sanitary sewers. The EEAA has started several education programs for a Compliance Action Plan (CAP) in the region, although the efforts are minor and insufficient. The task group studied the industrial wastewater issues through the cooperation of EEAA in the Phase I period, and the cooperation will be extended to the Ministry of Industry and other concerned parties in the next phase.

Policy #3 ***Minimize the discharge of industrial wastewater to municipal sewers and agricultural drains. Agricultural drains are not open dumping sites for industrial wastes, and pre-treatment of industrial toxic wastes at the source is a must.***

Procedures *EEAA should extend its effort of restricting industrial waste dumping in the Nile River to the agricultural drains and city sanitary sewers. New industries, either large or small, must meet the at-source treatment requirements for permitted operation. MWRI, in cooperation with EEAA and MOHP, should establish more restrictions on industrial wastewater discharge in agricultural drains.*

4. Health Concerns and Wastewater Quality Standards

The primary constraint to wastewater reuse in irrigation is the human health risk from pathogens carried by wastewater. Effluent water quality standards and regulatory efforts are mainly driven by human health concern.

4.1 Pathogenic Threats to Human Health

Urban wastewater carries the full spectrum of excreted human pathogens, including helminthes, protozoa, bacteria, and viruses. Pathogens can survive in the environment for a long time. Among the four types of pathogens, helminthes represent the most effectively transmitted pathogens in wastewater irrigation. Continuous exposure and infection by helminthes can result in a buildup of worm loads in the human body -- there is little or no immunity to helminthes. Common types of helminthes in developing countries are ascaris and trichuris. Appendix 2 presents information and an analysis of human health impacts and water quality standards in the international and Egyptian contexts.

Wastewater irrigation involves the risk of disease transmission. Pathogens in human waste are the main threat. However, few credible epidemiological studies of quantifiable human health effects have been carried out. Whether or not people actually get infected after working in wastewater irrigation fields or eating wastewater-irrigated vegetables depends on many factors, such as the infectious dose, state of immunity, and contamination routes. People should not panic about wastewater irrigation which has been practiced for thousands of years and is increasingly applied today in many water-short countries. Simple but effective prevention measures for individuals are avoiding eating raw vegetables and avoid direct contact with wastewater.

Policy #4 ***The primary threats of wastewater irrigation to human health are pathogenic organisms found in wastewater including bacteria, viruses, protozoa, and helminthes.***

Procedures *MOHP, in cooperation with MWRI and NOPWASD, should strengthen public awareness education on the human health risks of wastewater irrigation. All cooperating ministries should establish a better understanding of the various potential mitigating measures and their applications under the Egyptian conditions. MOHP should increase its scientific research to examine human health risks from wastewater irrigation in the Egypt. NOPWASD should pay more attention to the effective removal of pathogens in treatment plants.*

4.2 Wastewater Quality Standards

<u>California wastewater treatment requirements</u>

Wastewater treatment requirements were first issued by the California State Health Department in 1918 and are still in effect. The regulations restricted wastewater irrigation on salad crops by a quality standard of less than 2.2 coliform bacteria counts per 100 ml. This is extremely stringent, compared to that of 5,000/100 ml in Egyptian Law 48 and

1,000/100 ml in WHO 1989 Standards. Today, California uses tertiary treatment to achieve the standard.

<u>WHO 1973 Guidelines</u>

The World Health Organization (WHO) published public health policy guidelines on wastewater reuse. The guidelines relaxed the California standards by allowing effluents to contain 100 coliform bacteria counts per 100 ml in 80% of the samples.

<u>Engleburg Meeting</u>

A group of international experts re-assessed the practice and standards of wastewater irrigation in developing countries during a meeting held in July 1985 in Engleburg, Switzerland. The assessment established an understanding of human infection risks with wastewater irrigation: high risk with intestinal nematodes, moderate risk with bacterial infections, and minimal risk with viral infections. They found that the risks associated with trematodes and cestode infections, schistosomiasis, clonorchiasis, and taeiasis depend on local circumstances.

<u>WHO 1989 Guidelines</u>

The conclusions from the Engleburg Meeting were modified by WHO and published as WHO Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture in 1989. The Guidelines are internationally recognized, and have been adopted by many countries as the foundation for their own standards. The core contents of the guidelines are:

- For unrestricted irrigation of all crops including vegetables, the delivered water should include (1) no more than one nematode egg (ascaris, trichuris, or hookworm) per 1,000 ml, and (2) a geometric mean no more than 1,000 fecal coliform bacteria per 100 ml.
- When raw-eaten crops are excluded (restricted irrigation), only the above nematode standard (1) is required following a 5-day wastewater detention period in a stabilized pond.

<u>Law 48/1982</u>

Law 48/1982 is the super law regarding water quality management in Egypt. As mentioned in Chapter 2, the Law is unique compared to other standards or requirements by specifying the quality requirements of discharging flow at the two mixing points: effluents to drains and drainage to canals. This relates well the practice of wastewater effluent disposal and drainage reuse in Egypt. In the context of water microbial features, the Law set 5,000/100 ml coliform bacteria counts as discharge permit at the two mixing points. It is less restrictive than the WHO Guidelines, but better fits the quality reality in the Nile watercourses. Unfortunately, implementation and compliance with the Law has been unsatisfactory.

<u>MHUUC Ministerial Decree 44/2000</u>

Recently, the MHUUC, with the agreement and support of MOHP, issued Ministerial Decree 44/2000 (Concerning Amendment of the Executive Regulations of Law 93/1962 Pertaining to Discharging Liquid Effluents). The decree set a standard of 1,000/100 ml coliform bacteria counts for secondary treatment effluents, and 5 eggs and 1 egg of intestinal nematodes for primary and secondary treatment effluents, respectively. The decree strongly opposes the use of wastewater in irrigating vegetables, fruits, and other crops possibly eaten raw.

The California standards and WHO 1989 Guidelines represent two different schools of thought on water quality requirements in the international arena. The California standards are very stringent on fecal coliform bacteria, while the WHO experts considered such a conservative attitude on health unjustifiable in developing countries. WHO emphasizes the importance of helminthes while California does not mention helminthes in the standards. These variances demonstrate that water quality standards are relative to the level of economic development and that standards should reflect the local conditions.

The law 48 and MHUUC Decree 44/2000 together provide water quality standards related to wastewater discharge and drainage reuse. They may not be perfect on particular technical settings, but they are the authorized standards and should be respected by all involved parties.

The Nile freshwater prevailingly presents a higher coliform bacteria count than 1000/100 m. this raises a question of whether it is necessary, as well as possible, to treat the wastewater to a cleaner level than the freshwater. A standard of 5 intestinal nematode eggs per 1,000 ml for the primary treatment, as in MHUUC Decree 44/2000, seems to lack a scientific base. Many local MOHP or MWRI offices may not have adequate capability to conduct a test for intestinal nematode eggs. The classification of the different Nile watercourses for water quality standards application and opportunities ahead. Each cooperating ministry or agency has a significant contribution to make to wastewater management in Egypt.

Policy #5 ***The water quality requirements issued in Law 48 and MHUUC Ministerial Decree No 44/2000 represent the authorized standards in Egypt. All involved ministries and agencies should better recognize the role of MOHP in wastewater quality inspection and regulatory development.***

Procedures *MOHP should accelerate technical capacity building at both national and local levels for the increasingly complicated quality monitoring and inspection tasks. MWRI should classify the Nile watercourses for different water quality standard applications. MOHP, in cooperation with MWRI and other involved ministries, should develop clear responsibility lines in monitoring wastewater treatment plants, mixing points in drains and canals, lakes and seashores, unrestricted and restricted irrigation fields, and other sites of particular interest.*

4.3 Salaam Canal Water Quality

The MOHP Environmental Monitoring and Occupational Health Study Center conducted a sampling of the Mansoura treatment plant effluents; drain water in the Faroscour, Serw, and Hadous drains; and Salaam water at intake, drainage mixing points, and the Grand Siphon.

In the sampling, pathogens including total bacteria, fecal bacteria (vibriocholerae, salmonella typhoid, and other type salmonella), escherichia coil protozoa, and helminthes were analyzed. Tables 3 presents the sampling results and the relevant standards of Law 48, MHUUC Decree 44/2000, and WHO 1989 Guidelines.

The large numbers of intestinal helminth eggs detected in Salaam water are a cause for great concern. All samples showed exceedingly high intestinal helminth eggs, particularly ascaris, taenia, hookworms, and hymenolepis diminuta (Table 3). For instance, there were 720 ascaris eggs per 100 ml checked in Salaam after Hadous mixing, while WHO 1989 Guidelines and MHUUC Ministerial Decree 44/2000 allow only 1 egg per 100 ml for general (unrestricted) irrigation. This raises a question; does the Nile freshwater also contain high levels of helminthes? According to WHO information sources, water bodies in Jordan and several neighboring countries also reveal similar high level of helminthes. MOHP should conduct more research to evaluate the actual seriousness of the high helminth egg figures checked in Salaam Canal.

5. Discharge and Reuse of Wastewater Effluents

5.1 Separation of Wastewater

The full treatment of wastewater is far from reality. Agricultural drainage reuse is a mainstay and will continue in the Delta. An alternative to agricultural drains as wastewater dumping sites is not available and long-distance diversion of wastewater is impractical. Given these factors, a central need for separating or minimizing wastewater from general irrigation water remains. In this respect, MWRI faces a big challenge. Separation of wastewater will require the following measures:

- Classifying drains into two categories: *reuse drain* and *discharge drain*.

  Reuse drains have water acceptable for irrigation reuse. Untreated sewage should be kept out of reuse drains as much as possible. Discharge drains collect water that is of low quality without usability and should be discharged either to the sea or the desert. Each of the three Delta regions could have one or two *discharge drains* to collect and transport unwanted wastewater.

  For example in the East Delta, the Bahr Bagar drain carries a large volume of untreated sewage from Cairo and Kalubya governorates. Water in Bahr Bagar has no reuse value and the drain functions as a discharge drain. Reuse along the Bahr Bagar main drain should be prohibited. Agricultural drainage in the basin's branch drains can be intermediately reused. The huge effluent from the Gebel El Asfa WWTP, which is clean and expensive, should be kept out of Bahr Bagar to maintain its reusability.

- MWRI has adopted a policy to promote the reuse of cleaner branch drain water before the water goes to a polluted main drain. This policy should be aggressively implemented.

- Developing restricted wastewater irrigation to reduce the amount of wastewater entering the large-scale unrestricted Nile irrigation system. This will be discussed in detail in the following sections.

Policy #6 ***Separation of wastewater from agricultural drains is critical to sustain general irrigation in the Delta. Efforts in this direction, including drain function classification, intermediate drainage reuse, and wastewater tree-irrigation in the desert, should be recognized and supported.***

Procedures *MWRI, in cooperation with NOPWASD, MOHP, and local municipal authorities, should organize an overall drain classification program for the Delta. MWRI, in cooperation with local municipal authorities, should assess and implement, in steps, necessary penalties for discharging untreated wastewater into classified reuse drains and using drain water from classified discharge drains.*

5.2 Drainage Quality Monitoring

As discussed in Appendix 5, continuous and improved drainage quality monitoring is needed for effective management of irrigation quality. MWRI started its drainage monitoring system for combating drainage salinity issues two decades ago. The monitoring program has been expanded to include broader water quality content since the early 1990s. With the current monitoring program, MWRI has effectively sustained large-scale drainage reuse and unrestricted irrigation in the Delta. MWRI has established a qualified technical team and adequate facilities for water quality monitoring and management after the second mixing point (MIX-2).

Policy #7 ***The MWRI drainage-monitoring program has functioned as a main technical support in Delta region's water quality management during the past two decades. The program should be encouraged and continued.***

Procedures *MWRI, in cooperation with MOHP and EEAA, should upgrade the existing drainage monitoring program for more competent wastewater-related monitoring work.*

5.3 Restricted Irrigation

The large-scale unrestricted irrigation in the Delta is threatened by wastewater entering the system. To protect the unrestricted irrigation, restricted irrigation using pure or partially pure wastewater for tolerable crops should be developed. Restricted wastewater irrigation has been practiced in many countries for conserving freshwater.

Both WHO 1989 Guidelines and MHUUC Decree 44/2000 prohibit wastewater irrigation on vegetables, fruits, and raw-eaten salad crops, but allow reuse of wastewater effluents on restricted crops. The MHUUC Decree 44/2000 presents detailed specifications on what quality of water is appropriate for which crops and under what conditions, as shown in Table 4 below. The decree requires environmental impact assessment for restricted crop irrigation. For the Delta case, cautious evaluation of the possible negative impact of wastewater irrigation on neighboring groundwater aquifer is particularly important.

Policy #8 ***Follow the MHUUC Ministerial Decree 44/2000 and WHO 1989 Guidelines to initiate restricted irrigation for the safe use of wastewater on selected crops.***

Procedures *MALR, in cooperation with MWRI and MOHP, should plan crop zones for different quality irrigation sources in the Delta. MALR and MWRI should test pure wastewater irrigation for selected crops with cautious assessment of the possible groundwater contamination in neighboring areas.*

5.4 Timber Forest Irrigation in the Deserts

As described in Appendix 3, the Afforestation Department of MALR has successfully launched a campaign of wastewater effluent irrigation on timber trees over the past 6 years. Six pilot plantation projects with a total area of more than 2,000 feddans were implemented in the deserts from Upper Egypt to the Delta. The timber trees, particularly eucalyptus, acacia, mulberry, and khaya, have grown fast, are healthy, and have good economic return expectations. For the first time in modern Egyptian history, green forests appear in the deserts.

MALR policy on wastewater reuse: Use the wastewater effluents for growing timber trees in the desert, and do not use the water for fruits, vegetables, and field crops (Appendix 3). The policy is well consistent with the WHO 1989 Guidelines and MHUUC Ministerial Decree 44/2000.

Appendix 3 explains the rationale behind the policy:

- Egypt needs home-produced timber trees to reduce its reliance on expensive foreign lumber imports;
- Egypt needs to maintain the quality and reputation of its Nile water irrigated fruits and vegetables in the international agriculture market;
- Egypt's wastewater treatment program remains at the primary or secondary treatment level, and only in the future when more advanced and qualified treatment is adopted, could the effluent be used for ornamental plants, cut flowers, and fiber crops; and
- Egypt has not reached the point where water scarcity demands that fruits, vegetables, and raw-eaten salad crops have to be irrigated by sewage.

Wastewater irrigation of timber trees in the desert sounds promising. Appendix 3 includes a preliminary financial analysis of wastewater tree irrigation and answers questions raised by water sector representatives regarding the validity and eligibility of the proposed policy. Recently, MALR has decided to make 16,000 feddans of desert lands for timber tree plantation, and majority of the lands will be for private investors.

Assuming timber trees consume a similar quantity of water as general field crops (5000 m3 per feddan per year) and 50% of the wastewater effluents (1.2 bcm) are used for trees, a rough estimate of 240,000 feddans of timber trees could be grown in Egypt by using treated wastewater. That area is equivalent to 4 or 5 irrigation districts, and the expected economic return would be a source of revenue for the country.

Policy #9 ***Wastewater effluent irrigation on timber trees in the desert is an environmentally and economically sound reuse. The effort should be recognized, encouraged, and supported.***

Procedures *MALR should expand its current effort to promote wastewater irrigation of timber trees in the desert by strengthening public awareness education programs and by providing stronger economic incentives to attract private sector participation. MALR and MWRI should better cooperate to conduct environmental impact assessment, particularly groundwater impact evaluation, for wastewater irrigation in timber tree plantation.*

5.5 Urban Greenland Irrigation

Wastewater irrigation for urban greenland development is a step towards non-agricultural secondary reuse in cities. Given the heavy agricultural activities in the Delta, the potential for forest development in the Delta is limited. But newly developed cities and towns badly need public parks and street trees to build their green areas. Wastewater effluents should have a great reuse potential for this purpose.

Again, the MHUUC Decree 44/2000 provides wastewater reuse specifications for park grass, street trees, and other urban green lands to minimize human health risks.

The Afforestation Department of MALR, with the Dakhalia Governorate's cooperation, is planning a pilot program for wastewater tree irrigation on a 5-km length of the Mansoura highway. This kind of non-crop reuse represents a new way to dispose and absorb urban wastewater in the Delta, and should be encouraged and supported.

Policy #10 ***Use wastewater effluents to grow green lands in cities and towns in the Delta.***

Procedures *The Afforestation Department of MALR, in cooperation with MWRI and Dakhalia Governorate, should conduct a pilot program using wastewater effluents to grow street trees in Mansoura City. The pilot work should include an environmental impact assessment.*

6. Inter-ministry Cooperation

Water quality management demands the involvement and cooperation of government agencies, the private sector, and water users. Under this benchmark, representatives from five ministries organized a wastewater task group to address the status and problems of current inter-ministry cooperation in wastewater management (Appendices 1-5). The lack of a cooperation framework and financial mechanism was one of the major problems identified.

An established framework is important. In California, people work together under CALFED, a government-sponsored environmental program. The program involves 15 state and federal agencies and numerous private participants who plan actions to restore ecological health and improve water management. Activities are directly integrated into programs of the involved departments or agencies, and cooperation is integrated into regular office functions. The state and federal governments co-finance CALFED planning and coordination activities, and local beneficiaries, either users or city councils, pay the implementation costs. The terminology used in California refers more to obligation and contribution than to authority and responsibility.

In Egypt, many inter-sector cooperative activities are organized through special steering committees. These committees are not usually given legal status for decision-making. Inter-ministerial activities are regarded as additional activities, not integrated into the regular office operations. Without a cooperation framework, the scope of authority and responsibility is vague and fragmented. More than one ministry may declare authority in a particular field, while no ministry demonstrates concern in carrying out responsibilities in another field; and the effort made by one party may be inconsistent with other parties' interests.

Policy #11 ***Inter-ministry cooperation is the foundation of the urban wastewater management endeavor. MWRI, as the national water authority, has to take the lead in developing and sustaining the cooperation.***

Procedures *Establish a commonly agreed cooperation framework, clarify each party's authority and obligation lines, and establish a financial mechanism to support cooperation in water quality management.*

7. Conclusions

Reuse of municipal wastewater in irrigation is practiced in many parts of the world. Although certain health risks are associated with wastewater irrigation, it can offer potential benefits by reducing pollution in receiving water bodies (mainly agricultural drains in the Egyptian context) and increasing fertilizer and vital nutrients. It is important to have the right policies and implementation procedures in place.

This document identifies critical issues in Egypt's urban wastewater management practices, and presents remedial policies and accompanying procedures recommended by the APRP/MWRI Wastewater Task Group. Table 5 below lists the contents of these recommended policies and procedures.

Table 5. List of Recommended Policies and Procedures

Focused Areas	*Contents of Policies and Procedures*
Wastewater treatment	1. Prioritizing construction of treatment plants at given budget levels. 2. Making existing treatment facilities function. 3. Treating industrial wastewater at the source.
Health concerns and wastewater quality standards	4. Recognizing pathogenic threats on human health in wastewater irrigation. **5. Understanding wastewater quality standards, MHUUC Decree 44/2000, and MOHP role in wastewater quality inspection and regulatory development.**
Reuse of wastewater effluents	**6. Separating untreated sewage from reuse drains.** **7. Encouraging MWRI efforts in drainage monitoring.** **8. Initiating restricted crop irrigation.** **9. Using wastewater effluents to grow timber trees in desert areas.** 10. Using wastewater effluents to grow urban green lands.
Inter-ministry cooperation	**11. Establishing a cooperation framework including division lines of responsibilities and financial mechanisms for cooperation.**

The rationale for the development of these policies is summarized as follows:

- The discharge of a large volume of concentrated urban sewage into agricultural drains is the major threat to water quality in the Delta.

- The two wastewater-mixing processes (mixing with drainage in agricultural drains and mixing with freshwater in canals) disperse the pollution and degrade the water quality of the entire Nile irrigation system in the Delta. A central need for separating or minimizing the entrance of wastewater at these two mixing points remains. This is the fundamental impetus for the development of remedial policies.

- The discharge of wastewater "consumes" more potentially reusable drain water and an alternative to drains as dumping sites is not available in the Delta. Therefore, use of wastewater in the Delta is the most promising means to exhaust the water so that the negative effect on the general irrigation system can be minimized. All suggested optional uses of wastewater, including timber-tree irrigation, should be considered in this respect.

- A priority task in wastewater treatment is to improve the performance of existing wastewater treatment plants. Law 48 and MHUUC Decree 44/2000 provide sufficient guidelines for better wastewater management that should be respected by all involved parties. Inter-ministry cooperation is the foundation of the wastewater management endeavor and MWRI has the obligation to lead, support, and sustain cooperation efforts.

Ministry of Water Resources and Irrigation
US Agency for International Development
Agricultural Policy Reform Program
Environmental Policy and Institutional Strengthening Indefinite Quantity Contract

APRP - Water Policy Activity
Contract PCE-I-00-96-00002-00
Task Order 807

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER Discharge and Reuse

Report No. 34, Appendix 1
Wastewater Treatment in Egypt

December 2000

Water Policy Program
International Resources Group Winrock International Nile Consultants

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1. Introduction

Wastewater treatment in Egypt is one of the most essential activities of the government, as it affects the environment and the standard of living of the citizens. The objectives of wastewater treatment are:

- ***Health, environmental, social objectives:*** **These objectives are the most essential since a clean and healthy environment is the Government of Egypt's first priority at the present time. Wastewater treatment plays an essential role in the development of Egypt, as it helps prevent social diseases and harmful environmental impacts that lead to such diseases.**
- *Technical objectives:* This refers to the biological and chemical wastewater characteristics that affect the quality of effluents.
- *Economic objectives:* The economic objectives of wastewater treatment are manifested in the urgent necessity of wastewater reuse -- a result of environmental, social and political circumstances that make water a strategic national product.

2. Status of Urban Wastewater Treatment in Egypt

Wastewater Treatment Coverage

The Government of Egypt has made a significant effort towards providing wastewater services for its people. According to official figures, the coverage rates for wastewater services are much less than those for water supply. Just over 50 percent of the urban population has access to sewerage services, while the corresponding figure for rural areas is less than 10 percent. About 75 percent of the rural population uses septic tanks, cesspits and latrines, and more than 15 percent have no access to sanitation at all. Table 1 presents the wastewater treatment plants constructed and operating in Egypt since 1981.

Operations and Maintenance

The Technical Assistance Department of the National Organization for Potable Water and Sanitary Drainage (NOPWASD) is responsible for supervising operations and maintenance of the plants in all Governorates in the phase before the final handing over of the wastewater plants to the municipalities. NOPWASD's Technical Assistance Department consists of a number of engineers, chemists and technicians.

The operation and maintenance of each plant is the responsibility of the contractor to whom the plant is preliminarily handed over for one or two years (according to the contract conditions) and under NOPWASD supervision. After the final handing over of the plant, the operation and maintenance is the responsibility of the municipalities, whether it is a Public Economic Agency in some Governorates or the Engineering Department (city council) in other Governorates.

Table 1. Constructed Wastewater Treatment Plants in Egypt

	Governorates or Cities	Plant Names	Capacity (1,000 m^3/day)	Dates Starting Operation
1	**Damiatta**	Damiatta	60	1992
		Rass El Bar	50	1993
		Damiatta rural areas	17	1987-1992
2	**Daquahlia**	El Mansoura	135	1994
		Damas Village	2	1998
		Meet Mizah Village	1	1987-1992
3	**Sharquia**	El Zaggzig	60	1990
		Tenth of Ramadan	50	1987-1992
		El Salhia	18	1992 - 1997
		El Zankalon	2	1999
4	**Qalubia**	Benha El Qadima	26	1982
		Belqas	150	1992-1997
		Kafr Shokr	10	1998
		Meet Kenana	2	1998
5	**Kafr ElSheikh**	Kafr ElSheikh	18.5	1992
6	**El Gharbia**	Tanta	60	1992
		El Mahala El Kobra	90	1997
		Samanoud	11	1987-1992
7	**El Beheira**	Damanhour El Qadima	12	before 1952
		Kafr El Dawar	40	1992
		El Mahmodia	12	1992
		Shopra Kheet	6	1992
		Menshet El Horia	18	1997
8	**El Monufia**	Shebieen El Koom	60	1996
		Menouf	19	1995
		Qwisna	10	1998
		El Sadaat	15	1988
9	**Matrouh**	Matrouh	25	1998
10	**Port Said**	Port Said	190	1997
11	**El Ismailia**	El Ismailia	90	1996
12	**El Suez**	El Suez	130	1995
13	**El Giza**	Abou Rawash	700	1952
		Nahia	100	1982
		Sixth of October	100	1982-1987
14	**El Fayoum**	El Fayoum	40	1997
15	**Beni Suief**	Beni Suief	10	
16	**El Menia**	El Menia	20	
		El Fekria	40	1996
17	**Assyout**	Assyout	25	1993
			35	1997
18	**Sohag**	Sohag	22	1982-1987
19	**Qena**	Qena	30	1998
20	**Luxor**	Luxor	26	1997
21	**Aswan**	Aswan	21	1982-1987
22	**Cairo**	El Gabal El Asfr	1,500	1992-1998
		Fifteenth of May	80	1992-1997
		Helwan	700	1987-1992
		El Berka	600	1992-1997
		El Tenien	350	1992-1997
23	**Alexandria**	The Eastern Region	137	1992-1997
		The Western Region	180	1992-1997
24	**North of Sinai**	El Aresh	50	1992-1997
25	**South of Sinai**	Sharm El Sheikh	15	1992-1997
		Rass Sedr	5	1992-1997
		Abou Zenima	5	1992-1997
		Abou Radiss	4	1992-1997
		Katereen	2	1992-1997
26	**New Valley**	El Kharga	11	1987-1992
		Mout	11	1992-1997
		Total	**6,209**	(2.27 bcm/yr)

In the Governorates where Public Economic Agencies have not been established yet, NOPWASD is responsible for the operation and maintenance of the plants for one year after the preliminary handing over. O&M training should be provided to the engineers and technicians of the municipalities during this year.

Constraints and Problems

Financial constraints are quite severe in view of the huge investments required to fulfil the wastewater sector objectives. Inadequate O&M practices are always highlighted as one of the most troublesome aspects of wastewater sector management in Egypt. The main problem is a lack of qualified and trained technical staff and operational personnel to bear the required responsibilities. Furthermore, a lack of equipment, supplies and spare parts results in low efficiency of many treatment plants.

Effluent Quality Monitoring

NOPWASD has determined a proper monitoring system for every plant and in accordance with the applied technology of each plant. Monitoring tests are applied through wastewater treatment plant laboratory. Each laboratory has the equipment, materials and chemicals for the daily analysis necessary to assure that the treated effluents are in accordance with the standards of Law 48/1982 before being disposed into the water channels. During the first one or two years of operation and maintenance the engineers and technicians of the municipalities will be trained to bear the responsibility of O&M works.

During the first duration of O&M, NOPWASD chemical research department representatives analyze random samples, taken from the different stages of the treatment process, in NOPWASD central laboratories. In addition, random samples are taken by Ministry of Health representatives to ensure that the effluent quality of the plant is in accordance with the required standards before disposing the effluents into the channels. After the final handing over of the plant to the municipalities, effluent quality will be monitored by the municipalities through random sample analysis in the plant laboratory. Sometimes the municipality representatives perform these analyses in the Governorate central laboratories.

3. NOPWASD in National Wastewater Treatment

The Ministry of Housing, Utilities and Urban Communities established NOPWASD in the 1980s as a governmental authority working in water and wastewater (according to Decree No. 197/1981 and No. 30/1986). Before that, the Greater Cairo General Organization for Sanitary Drainage (GCGOSD) and the Alexandria General Organization for Sanitary Drainage (AGOSD) were working under the umbrella of the General Organization for Sanitary Drainage. NOPWASD is the combination of the General Organization for Potable water and the General Organization for Sanitary Drainage. Today, NOPWASD, GCGOSD and AGOSD continue their previous relation to develop, upgrade and update the wastewater treatment policies, technologies and technical cadres.

At the national level, NOPWASD is managed by a board of directors, including NOPWASD Chairmen and senior officials, the chairmen of GCGOSD and AGOSD, representatives of water and wastewater organizations of greater Cairo, Alexandria water and wastewater organizations, Ministry of Housing and Public Utilities, Ministry of Water Resources and

Irrigation, Ministry of Planning, Ministry of Health and Population, university professors and experts in the field of water and wastewater.

At the local level, NOPWASD is managed by the heads of Executive Departments in every Governorate, with their technical and administrative staff.

NOPWASD's Authorities and Responsibilities

- Preparation of policies of water and wastewater projects at the national level; preparation of their implementation schedules.
- Provision of consultation and technical assistance for studies, research, project design, tender documents, and preparation for contractors and suppliers, as well as implementation, supervision and staff training.
- Coordination between water and wastewater projects to achieve integration.
- Preparation of water and wastewater studies and applicable research. Participation in determining the standards for potable water and wastewater disposal.
- Defining of conditions and technical standard specifications for water and wastewater projects, domestic use, and general use for productive projects.
- Provision of technical assistance for water and wastewater fields.
- Training for technical staff of all Governorates to improve their abilities in design, execution, operation and maintenance of water and wastewater utilities.

Reforms in the Water and Wastewater Sector

The GOE has made huge investments in projects to provide public water and wastewater services in the past decades. Although the investments are large, there are still many projects incomplete in many Governorates due to insufficient financial sources, inadequate experience, fragmented and overlapping management, and other reasons. The government has concluded that water and wastewater sector reform is necessary and desirable. MHUUC has submitted a sector reform plan to the Cabinet for an overhaul of the present institutional structure. The Cabinet approved nationwide reorganization of the sector and preparation of new decrees for better performance in supervising, planning, and implementing the nation's water and wastewater activities.

Based on the above, a steering committee with extensive representation from central and local level stakeholders was formed under the chairmanship of the Chairman of NOPWASD, assisted by a technical secretariat and a consulting group. A draft presidential decree has been approved by the leading committee of the Ministry of Housing, Utilities and New Communities. The principal objectives of the water and wastewater sector reform is to enable and encourage utilities to achieve new standards for service and performance, to enable and encourage utilities to achieve operating cost recovery, and to encourage the private sector to finance, manage, and operate projects in the sector. One of the principal components of the proposed reform is creation of an enabling environment for private participation. The proposed framework provides three supports for private sector participation, as follows:

- A law on concessions in the water and wastewater sector, removing constraints and risks in the public utility concessions law 127/1949.

- The assignment of an independent regulatory agency to increase investor confidence in the certainty of gaining a return on investment. This measure has been effected in other utility sectors in Egypt.
- A presidential decree creating a central department for private sector participation in the Ministry of Housing, Utilities and New Communities. This department would develop private sector participation strategies and procedures, assist and advise local utilities, and serve as a clearing-house for interested private investors.

Public Economic Agencies
Seven Public Economic Agencies were established under Presidential Decree No. 281/1995 in Daquahlia, Gharbia, Sharqui, Fayoum, Beniswef, El Menia, and Aswan. These Public Economic Agencies are responsible for:

- operation and maintenance of the plants that are handed over by NOPWASD to the municipalities;
- construction of networks in small villages and construction of house connections; and
- preparation of general and detailed plans for water and wastewater projects.

The responsibilities of the Public Economic Agencies are limited because of the following reasons:

- lack of financial allocations;
- lack of qualified technical cadres to bear the required tasks and responsibilities;
- poor institutional structure and lack of advanced management systems; and
- lack of technical and administrative experience of the Public Economic Agencies' staff.

In addition to the seven Public Economic Agencies, the following have been proposed:

- Establish a Public Economic Agency in each of the Governorates of Giza, Menufiya, Qalyubia, North Sinai, South Sinai, Qena, Sohag, Red Sea, and Luxor.
- Establish one Public Economic Agency for the three Governorates of Suez, Port Said, and Ismailia.
- Establish one Public Economic Agency for the two Goverorates of Asiut and New Valley.

One of the principal components of the proposed reform is corporatization of local utilities -- a process of transforming dependent public utility organizations into viable commercial enterprises. The role of these companies at the local level shall be as follows:

- Prepare plans for the water and wastewater sector at the Governrate level according to the principles and criteria developed by NOPWASD.
- Prepare cost and service pricing studies on the basis of principles and criteria developed for the proposed regulatory agencies.
- Determine technical, economic, financial, and environmental performance criteria targets to be achieved in all utility units during a specific period of time.
- Submit these studies and the determined performance criteria to the regulatory agencies for approval, and submit periodic reports on them.
- Implement projects incorporated into their plans. To this end, they shall prepare tender documents, tenders, awards, and contracts; hold tenders and negotiations; and supervise implementation thereof.
- Implement programs to enhance technical efficiency and rehabilitation projects, so as to reduce losses and enhance performance level.

- Implement projects to enhance and develop the technical and administrative efficiency of the authority's staff.
- Conclude, with the private sector, service delivery contracts and public utilities concession contracts for the establishment, management and maintenance of water and wastewater plants and networks.
- All operations of private sector projects within the Public Economic Agency's geographical scope shall be subject to the performance criteria and tariff schedule approved by the proposed regulatory agency.
- Manage, operate and maintain water / wastewater facilities in the Governorate; secure required financial resources according to the performance criteria and the tariff schedule approved by the proposed regulatory agency.
- Supervise all water / wastewater projects implemented in the villages and cities within the Public Economic Agency's geographical scope by any governmental entity or local community organization, including awareness programs, community participation programs, and programs supporting the role of non-governmental organizations.

BOT is one of the privatization mechanisms that will be applied to finance the wastewater projects. As it is the responsible organization for the water and wastewater sector in 22 Governorates, NOPWASD is starting to apply the BOT approach to financing wastewater projects. Under the BOT approach, NOPWASD will work as a consultant, reviewing the tender documents of the project and providing the technical supervision and monitoring during the concession period.

4. Priorities in Treatment Plant Construction

National Plan Development

The bleak macroeconomic situation of Egypt in the mid-sixties, combined with population growth and migration to large urban centers, meant that by the 1970s, nearly all Bab III funding was allocated to the cities. This was particularly the case in predominantly agricultural Governorates. At present the entire process is highly politicized in each Governorate. All cities in each Governorate are in competition for financial resources (Bab III ministerial, Bab III municipalities and a variety of local special funds and donors) with all other cities at the same level.

As soon as the priorities are determined in the Governorate, the Governorate submits these priorities to NOPWASD. NOPWASD reviews the Governorate's priorities through their records of each Governorate's needs assessment and the guidelines of the Ministry of Planning. Then NOPWASD sends these priorities to the Ministry of Planning to be considered in the annual plan.

PLANT CONSTRUCTION PRIORITIES

The GOE has made a significant effort to improve wastewater services for its people. According to official figures, about 26 wastewater projects were implemented up to 1982. At the end of 1999, about 300 projects had been implemented. By the end of the 2002-2007

plan, the number of the wastewater projects is projected to be 568, representing about 70% coverage of wastewater services.

NOPWASD has prepared a detailed study of the planned projects, since it determines the priorities of project construction, according to the level of pollution.

The basis for water pollution control in the Nile Basin is Law 48, which regulates the discharge of any pollution in the Nile. Discharges are allowed only into agricultural drains if proper treatment is provided for most of the wastewater. After issuing environmental Law 4 of 1994, the ministerial committee chaired by the Prime Minister in February 2000 (which discussed procedures for protecting the Nile, canals and drains) requested that each ministry determine the pollution sources and loads within its activities and prepare a detailed plan for pollution treatment including time schedules, cost and construction priorities.

Table 2 summarizes the priorities in treatment plant construction. Tables 3-7 show the details of each construction priority, based on the criteria of pollution prevention (health parameter), and proximity to the mixing points.

First Priority *(Table 3)*
This first priority includes the sewage treatment plants that discharge their effluents into the Nile or its branches, since the Nile is the source of most of Egypt's potable water. In other words, this priority reflects the highest priority: health. This list also includes the sewage treatment plants that dispose their effluents into El Serw and Hadous drains. These plants will protect the quality of the water that feeds the Salam Canal, since an amount of water from these two drains is pumped up after mixing with the Nile water at the end of Damietta branch.

Second Priority *(Table 4)*
The second priority includes the sewage treatment plants that discharge their effluents into lakes where fishery development is important.

Third Priority *(Table 5)*
This priority involves the sewage treatment plants that discharge their effluents into drains leading to the Mediterranean Sea, since the Mediterranean coast includes what are considered the most important beaches in Egypt.

Fourth Priority *(Table 6)*

2. This priority includes the sewage treatment plants that discharge their effluents into drains leading to Quaron and El Rayah lakes. This priority is designed to prevent the pollution caused from the Ebshewai, El Wady, and Bats Drains.

Fifth Priority (Table 7)
This priority is outside of the programs for both irrigation and drainage systems in Egypt (pollution of Nile – canal – drains systems), but it represents the completion of the 1997-2002 plan for different projects. Some of these projects are under construction.

Budget Constraints

The budget has always been a constraint to treatment plant construction. Table 8 below shows the NOPWASD investment record in the past ten years.

Table 8. NOPWASD Investments in Wastewater Treatment

Year	**Actual Investments** (million LE)
1992-1993	392
1993-1994	684
1994-1995	960
1995-1996	1,300
1996-1997	2,428
1997-1998	1,559
1998-1999	1,616
1999-2000	1,524
TOTAL	10,464

Note: The 1996-1997 figure includes USAID funds on Canal City Projects.

5. INTER-MINISTRY COOPERATION

Cooperation between NOPWASD and other ministries in the water and wastewater sector is the crucial to effective execution of these projects. The involved ministries are:

- Ministry of Housing and Utilities and Urban communities
- Ministry of Local Development
- Ministry of Water Resources and Irrigation
- Ministry of Planning
- Ministry of Scientific Research
- Ministry of Electricity and Energy
- Ministry of Agriculture and Land Reclamation
- Ministry of Industry and Mineral Wealth
- Ministry of Environment Affairs

Coordination between NOPWASD and the above mentioned ministries has aimed at the following objectives:

- Avoiding project duplication.
- Preparing and reviewing the national plan to provide wastewater services to all areas and to determine implementation priorities.
- Preparing the necessary studies to ensure technical, economic, financial and environmental efficiency of wastewater projects.
- Updating and increasing the efficiency of the reuse of treated wastewater.

- Periodically reviewing and updating wastewater sector laws, their executive regulations and ministerial decrees.
- Solving the land acquisition problems that used to affect many projects, ie., acquiring the required land to implement the project before the tendering process of each project.

The coordination procedures between NOPWASD and other involved parties are as follows:

Ministry of Local Development

Positive steps have been taken with this ministry to avoid the duplication of projects and to follow the needs assessment records.

Ministry of Water Resources and Irrigation

Since 1996 (Decree No. 373/1996 and No. 449/1996), the Ministry of Public Works and the Ministry of Housing have a joint ministerial committee to achieve positive solutions for the sector's problems. The above-mentioned decrees were issued with the following representatives:

- NOPWASD Chairman, vice chairman and senior officials.
- Wastewater Organization of Greater Cairo and Alexandria.
- Chairman of Egyptian Public Authorization for Drainage Projects.
- Chairman of Drainage Research Institute and Nile Research Institute.
- Experts and professors from different universities and research centers.

The combined ministerial committee is facilitating the execution of wastewater services and helping to prevent the pollution of the Nile and its channels by applying the standards of law 48/1982.

The Ministry of Water Resources and Irrigation and Ministry of Housing, Utilities and Urban Communities are coordinating to determine the project's priorities in the five year plan according to an integrated strategy for handling sewage disposal and reuse. The two ministries also coordinate to determine the necessary amount of water for the sector and the existing capacities of the drains related to wastewater disposal from the wastewater treatment plants.

Ministry of Planning

Continuous coordination between NOPWASD and the Ministry of Planning is necessary to prepare the financial allocations for the projects.

Ministry of Scientific Research

NOPWASD and the Ministry of Scientific Research communicate continuously regarding modified and updated technologies in the wastewater field.

Ministry of Electricity and Energy

Electrical distribution companies and the Agency of Rural Electricity coordinate to ensure that the national projects have electricity.

Ministry of Agriculture and Land Reclamation

Coordination between NOPWASD and the Ministry of Agriculture is essential since most of the sewage treatment sites are located in agricultural lands, especially in Lower Egypt. NOPWASD and the different agencies of the Ministry of Agriculture work together to determine the quality and quantity of treated wastewater necessary to cultivate some of the desert lands with man-made forests, as in regions in Ismailia, Luxor and Sedat City. The two agencies are considering cultivating an area near to 6th of October City as well.

Ministry of Industry and Mineral Wealth

Cooperation and coordination between the Ministry of Industry, governmental agencies, and the private sector helps the government to manufacture local wastewater equipment. A recent study has been prepared by the Investment Bank and the Ministry of the Military Production to compare the quality of locally-manufactured electromechanical equipment with the same quality of imported equipment. In addition, all the different kinds of pipes are manufactured locally, as well as switchboards.

Ministry of Environmental Affairs

Law 4/1994 has determined the required coordination among all the different agencies and organizations to prevent environmental pollution. In this regard, NOPWASD has prepared studies for the establishment of wastewater treatment plants and their environmental effects. In addition, NOPWASD designs and supervises the execution of the wastewater compact units for cruise boats and other boats on the Nile, to prevent pollution of the river.

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US Agency for International Development
Agricultural Policy Reform Program
Environmental Policy and Institutional Strengthening Indefinite Quantity Contract

APRP - Water Policy Activity
Contract PCE-I-00-96-00002-00
Task Order 807

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 34, Appendix 2
Health Impact and Water Quality Standards in Wastewater Irrigation

November 2000

Water Policy Program
International Resources Group Winrock International Nile Consultants

Task Order No. 807
Contract No. PCE-I-00-96-00002-00

Report No. 34

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Appendix 2

Health Impact and Water Quality Standards In Wastewater Irrigation

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Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)
Partners: *International Resources Group, Winrock International,*
and Harvard Institute for International Development
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1. Introduction

Population growth is among the most pressing challenges faced by Egypt in its development. According to the latest census results, the total population in Egypt is 59.3 million (irrespective of nationality and not including the 2.18 million Egyptians living abroad). About 25.2 million live in urban areas and 34.1 million in rural areas (Central Agency for Public Mobilization and Statistics, 1996).

Agriculture in Egypt is almost entirely dependent on irrigation from the Nile, since there is no significant rainfall except in a narrow strip along the Mediterranean Coast. The agricultural land base consists of old land in the Nile Valley and Delta, rain-fed areas, several oases, and lands reclaimed from the desert. Expansion into new lands is considered necessary for increased agricultural production and for accommodating the growing population. Egypt is now fully utilizing its share of the Nile River flow and is effectively reusing drainage water, treated wastewater and shallow groundwater.

New water projects, such as El Salaam Canal and Toshka, are being carried out by the GOE. These projects will have large impacts on the distribution and use of available water resources. Continued population and economic growth will exert further pressure on the existing water resources. Horizontal expansion is one of the main targets for enlarging the cultivated area in Egypt. This could easily be achieved in the desert around the Nile Valley and Delta. Wastewater is used in agriculture at many levels, starting from unofficial reuse by farmers abstracting water directly from open drains close to their fields, up to the new huge project of El-Salaam Canal.

The present water management system strongly depends on the reuse of drainage water, as all the drainage water of Upper Egypt is discharged into the Nile (about 2.6 bcm/year). Drainage water in the Delta is recycled for irrigation by mixing part of the flow of the main drainage system with water in the main irrigation canals. Various reuse pumping stations in the Delta and Fayoum convey drainage water back into the irrigation canal system and into the Nile. Using the water twice or even three times increases the salinity up to the order of 3,000 ppm or more in drains near the lakes boarding the Mediterranean Sea. The mixing of drainage water with relatively clean irrigation water further diffuses all kinds of constituents, and negative environmental and health impacts are very much related to the big load of municipal wastewater discharge.

In Egypt, since 1930, sewage water has been utilized in cultivating orchards in sandy soil areas in El Gabal el Asfar, Abu Rawash and different small areas such as Tibbin and Assiut. Today, the majority of sewage water, amounting to more than 2 bcm per year, is discharged into agricultural drainage channels. Part of this water receives secondary treatment while the rest is drained after primary treatment or raw. Although drainage reuse is mentioned often as one of the main ways to provide enough water in the future, no formal policy exists that includes the effects, risks and alternatives.

2. History of Wastewater Treatment and Reuse

Large-scale cropland application of municipal wastewater was first practiced about 150 years ago after flush toilets and sewage systems were introduced into cities in western Europe and North America. The wastewater was discharged without any treatment, and receiving watercourses became heavily polluted. As a partial solution to the problem, sewage farms were developed. The agricultural benefits from the farms were incidental compared to their service in the disposal of the wastewater.

The practice of sewage farms quickly spread. By 1875, there were about 50 such farms in England, and many similar farms served major cities in Europe. By the turn of the century, there were about a dozen sewage farms in the United Sates.

While sewage farms alleviated pollution in the receiving streams, they created a different set of environmental sanitation problems like soil clogging, waterlogging, odorous smells, and contamination of food crops. Sewage farms were gradually phased out when the land area required to accommodate waste from large cities grew too great, and more effective technologies were developed to remove pollutants from wastewater. After the First World War, sewage farms disappeared completely in many countries, since wastewater could be readily discharged to surface waters without causing significant pollution.

In recent decades, there has been great interest in the use of wastewater for crop irrigation, especially in semi-arid areas of both developed and developing countries. The shift to reuse can be attributed to several factors such as:

- The scarcity of alternative waters for irrigation.
- The high cost of artificial fertilizers.
- The health risks and soil damage demonstrated are minimal if the necessary precautions are taken.
- Recognition by water resource planners of the value of the practice.
- The high cost of advanced wastewater treatment plants.

In Egypt the first use of treated wastewater as a source of irrigation and plant nutrients was in 1915 in the Eastern Desert, northeast of Cairo. An area of 2,500 feddan is still being irrigated with wastewater from primary treatment. With the scarcity of water resources, 150,000 feddans of lands are scheduled to irrigate with treated wastewater before the year 2002.

3. 3. Health Impact of Wastewater Irrigation

To counteract the scarcity of water resources, treated wastewater should be recognized as a reliable source of water. However, some reservations about water reuse exist, due to potential health risks associated with wastewater. A major health risk emerges from fecal contamination of water from household use. Fecal matter may introduce certain microorganisms or agents capable of causing diseases in people who come in direct contact with wastewater or use products grown through the use of wastewater.

Another cause of health problems associated with wastewater reuse in agriculture is the mixing of industrial waste with municipal waste. Industrial waste includes many pollutants that interfere with wastewater treatment processes, especially biological treatment. The presence of heavy metals in municipal wastewater is one factor that may limit the application of reuse of wastewater in agriculture. Accumulation of heavy metals in soil, affecting crops; accumulation in edible parts of plants cultivated in soil that was irrigated with wastewater, whether these plants are used for human or animal consumption; and the possible effect on groundwater are all factors the should be considered.

Although water quality assessment studies and the monitoring activities carried out since 1975 have provided considerable information about water quality in Egypt, a lot of data is still unavailable such as: water quality in irrigation canals and the magnitude of the pollution problem from human sources. It is generally agreed that the major water quality problems in Egypt are:

- pathogenic bacteria, viruses, protozo, and helminthes
- heavy metals
- pesticides

The indiscriminate discharge of untreated human waste into water bodies has created significant pollution problems with serious health implications, especially in rural areas where there are no appropriate sanitation systems. The reuse of wastewater for irrigation in Egypt started early in this century (directly or indirectly through the illegal discharge of untreated wastes into water bodies). Since 1930, sewage water has been used in cultivation of orchards in sandy soil areas (El Gabal El Asfar, Abu Rawash and different small areas such as Tibbin and Assiut).

In developing countries, excreta-caused diseases are rather common, as wastewater contains high concentrations of excreted pathogens (viruses, bacteria, protozoa, and helminths) that cause diseases in humans. The agricultural reuse of effluents results in an actual risk to public health if all the following stages occur:

a) Either an infective dose of an excreted pathogen reaches the irrigation field, or

b) the pathogen multiplies in the field to form an infective dose.

c) This infective dose reaches a human host.

d) This host becomes infected

This infection causes disease unless d) does not occur, in which case a), b), and c) pose only a potential risk to public health

Pathogens affect different population groups differently. Four groups of people who are at potential risk from the agricultural use of wastewater and excreta are:

- agricultural field workers and their families
- crop handlers
- consumers
- persons living near the wastewater irrigated fields.

The following factors play an important role in the transmission of communicable diseases through use of wastewater effluents in agriculture.

Survival of pathogens in soils, crops, and effluents
Pathogen survival outside the human body depends on their resistance to environmental effects. Available evidence indicates that almost all excreted pathogens can survive in soil and effluents for a sufficient length of time to pose potential risks to farm workers. Helminthes live longer than bacteria and protozoa (Asaris eggs can survive many months in soil and up to 60 days on crops; fecal coliforms live 70 days in soil and 30 days in crops). Pathogen survival on crop surfaces is much shorter than that in soil, as the pathogens are less protected from the effects of sunlight and desiccation. In some cases, however, survival times can exceed the length of the crop growing cycle, posing potential risks to crop handlers and consumers.

Mode and frequency of effluent application
The degree of crop contamination and the dispersion of pathogens associated with wastewater depend upon the way in which effluent is applied to land, the interval between successive applications, and the interval between the last application of effluent and harvesting.

Type of crop grown and type of exposures
The production of agricultural crops intended for human consumption poses risks mainly to consumers and workers. In fodder crops, farm workers and consumers of the resulting meat or milk are at potential risk. In the case of industrial products, only farm workers and product handlers are subjected to risk. In the case of sprinkler irrigation, nearby populations are at risk. The greatest risk is associated with crops eaten raw, especially if they are root crops. Pathogen survival times in these crops can be greater than crop growing time, so that contamination is highly likely unless wastewater effluent is carefully treated to the required standard.

Environmental Impacts

The principal environmental risks that may be associated with wastewater are:
- Spread of pathogens,
- Oxygen depletion by organic contaminants,
- Chemicals in susceptible ecosystems (mainly water resources).

Wastewater irrigation can potentially transport bacteria and viruses to groundwater. Helminth cysts and worm eggs are reported to be too large to be transported to groundwater.

Viruses are a special concern in wastewater irrigation because virus particles are small, may percolate through soil, and may persist for months in the soil environment. Several ground water samples were taken 27.5 meters below wastewater soil application sites and were found to be positive for animal viruses.

Bacteria that are used as indicators of wastewater contamination (fecal coliform and fecal streptococci) have been found in soil water at a depth of 1.37 meters below fields irrigated with treated but non-disinfected wastewater effluent. Application of treated wastewater effluents to soils may pose risks of groundwater contamination by viruses and bacteria.

Heavy Metals. Through cation exchange, chemical exchange, chemical sorption, precipitation and complex cation reactions, metallic ions are readily removed from wastewater and concentrated in sludge. Most heavy metal cations would not be expected to leach out of the unsaturated soil zone into groundwater.

Toxic Organic Compounds. A few toxic organic compounds and detergents have been found in sludge because they are either biodegradable in soils or absorbed strongly by soil particles. These compounds are not a risk for groundwater contamination.

Epidemiological Evidence

The actual public health importance of excreta or wastewater reuse can be assessed only by an epidemiological study to determine whether it results in measurably greater incidence of disease, or intensity of infection, than occurs in its absence. Such studies are methodologically difficult, and there have been only a few well-designed epidemiological studies on human waste reuse. More evidence is available about wastewater irrigation than about excreta use in agriculture or about aquacultural use (WHO, Geneva, 1989).

A World Bank report reviewed all available epidemiological studies on wastewater irrigation and concluded that:

- Crop irrigation with untreated wastewater causes significant excess intestinal nematode infection in crop consumers and field workers, especially those who work barefoot. Such field workers are likely to have more intense infections, particularly from hook worms, than those not working in wastewater–irrigated fields. Irrigation with adequately treated wastewater does not lead to excess intestinal nematode infections in field workers or crop consumers.
- Cholera, and probably typhoid, can be effectively transmitted by irrigation of vegetable crops with untreated wastewater. There is limited evidence that the health of people living near fields irrigated with raw wastewater is negatively affected.
- Sprinkler irrigation with treated wastewater may promote aerosol transmission of excreted viruses, but this is likely to be rare in practice because most people have normally high levels of immunity to endemic viral diseases.
- When untreated wastewater is used to irrigate crops, there is a high health risk from intestinal nematodes and bacteria but little or no risk from viruses (WHO, Geneva, 1989).

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Excreta Use in Agriculture

Use of excreta in agriculture is practiced in many developing countries. Crop fertilization with untreated excreta causes significant excess intestinal nematode infection in crop consumers and field workers. There is evidence that excreta treatment can reduce the transmission of nematode infection. Excreta fertilization of rice paddies may lead to excess schistosomiasis infection among rice farmers.

Egyptian Statistics

According to Ministry of Health statistical data, the prevelance of gastrointestinal diseases in Egypt was 24.6 % in males and 15.7% in females admitted to hospitals in 1998. According to CAPMAS data from 1994, the mortality rate due to gastro-intestinal diseases was 6.27% for males and 4.03% for females.

There were 7,522 reported cases of typhoid and paratyphoid in 1998 (10.4% of the total reported cases of infections diseases). The highest incidence rates were found in the governorates of New Valley, Suez, Assiout, Menonfia, Kalioubia, and Sharkia (MOHP).

The total reported cases of viral hepatitis in 1998 amounted to 13,340 (18.38% of total reported cases of infectious diseases), but the number of hepatitis cases caused by viruses transmitted through the gastrointestinal route is not included. Schistosomiasis is reported to affect 10% of the population, especially school children and occupational groups (farmers and fishermen).

There is no epidemiological evidence of the relation between wastewater use in agriculture and level of infections. Another potential toxicity problem is the accumulation of heavy metals in plant parts that enter the human food chain. Cadmium (Cd) for example could be present in municipal wastewater at levels that are not toxic to plants but that could build up inside the plants to levels harmful to humans or animals.

El Mowelhi et al (1994) estimated the heavy metal contents in barseem cuts and corn stalks. The study shows that continuous use of sewage effluents in irrigation increased heavy metal contents in plant organs to different degrees. The increase in barseem cuts were twice the normal limits for Fe, Mn, Zn and Pb; three times for Cu and Ni; seven times for cadmium; and 17 times for Cr. Similar trends were observed in corn stalks. The study concluded that the micro-nutrient and heavy metal content in both barseem cuts and corn stalks increased as the time of sewage water use increased. The increase was about 2 to 36 times in barseem cuts and 2 to 162 times in corn stalks, as compared with plants irrigated with fresh unpolluted Nile water. Metal toxicity was not observed.

Egyptian Sludge Characteristics

- *Heavy Metals:* The concentration of these elements in sludge is different in industrial areas from those of domestic areas but is still below the international limit.
- *General Characteristics:* Liquid sludge contains 4-6% dry solid, 60-70% volatile substances, and pH 6-7.
- *Nutrients:* The ratio of Nitrogen: Phosphorus: Potassium concentration in liquid sludge is 3%: 1%: 0.3%. The nitrogen concentration in Egyptian sludge is similar to that in Europe, while the Phosphorus is almost half. In digested sludge, the concentration of nitrogen decreases due to evolution of Ammonia. Also, sludge contains large amounts of Iron so it can be a source of iron for the soil. Sludge also contains small amounts of Copper and Manganese (Cairo Sludge Disposal Study).
- *Pathogens:* Anaerobic digestion can reduce the total content of pathogens, but it is not effective in reducing the parasites' eggs except under high temperatures (55^{o}C). All samples contain *E. coli*, mostly of the *Aerobacter* species. 25% of the samples contain *Proteus.* Parasite eggs are not found in all samples but when found, they are in large ratios of 24% at Abu Rawash, 47% at Berka, containing *Eimeria* 50 eggs/gm, 29% containing *Trichstrongylus* 50 eggs/gm and *Ascaris* 1-5 eggs/gm. In Zenien, it reaches 25 eggs/gm (Ascaris) as the largest contamination, but mostly it is around 1-5 eggs/gm.

Salmonella and *Ascaris* are considered to be the most critical problems in sludge reuse (Source: Agriculture Use of Sewage Sludge in Cairo, Final Report, Phase 2, May 1999).

4. Helwan Reuse Case

Another study was done by the Academy of Scientific Research and Technology, the Ministry of Health and Population, and the US Agency for International Development (1995) on the health impact of the Helwan wastewater reuse project. This was a project to reuse the effluent from Helwan treatment plant for the reclamation of 17,500 acres of desert. The laboratory investigations for Helwan sewage plant workers and some of the sewage farm workers showed the following:

- 38.2% had parasitic infections (Ascaris, Entamoeba Histolytica and Giradia).
- 18.4% were anemic.
- 27% had gastrointestinal symptoms (dysentry and enteritis).

A survey for the prevalence of some diseases that are related to wastewater, from 1994-1995 records of health offices in the area, showed the following:

- Population infected by diarrhea in 1994: 3.90 %; in 1995: 2.90%
- Population infected by dysentery in 1994: 0.82%; in 1995: 0.86%
- Population infected by Ascaris in 1994: 0.55%; in 1995: 3%
- Population infected by Bilharzia in 1994: 1.50%; in 1995: 2%
- Population infected by Tenia in 1994: 0.70%; in 1995: 0.30%

As the Helwan sewage treatment plant collects different kinds of industrial wastes, the analysis of effluent used in irrigation showed a great increase in cadmium, chromium and lead. Analysis of soil samples and of different parts of the plants irrigated by that water also revealed an increase in the concentration of heavy metals, especially cadmium, chromium and lead. This study was performed as part of a program for the sustainable development of Helwan (USAID grant).

5. Water Quality Along Salaam Canal

As planned in the wastewater and reuse benchmark (C2), the Environmental Monitoring and Occupational Health Study Center (of the MOHP) conducted a random monitoring of the water quality of Mansoura wastewater treatment plant effluent and several drainage mixing points on El Salaam canal. The samples were taken during the period from 8–17 April, 2000. The sampling sites were chosen to give an idea about the effluent quality at the Mansoura wastewater treatment plant, the water quality in Faroscour, Serw, and Hadous drains, and the effect of drainage mixing in Salaam Canal before the Grand Siphon.

The checked physical and bio-chemical parameters include pH, DO, TDS, BOD, and COD. The examined bacteria include total bacteria, fecal bacteria (Vibriocholerae, Salmonella typhoid, and other types of Salmonella), Escherichia coil protozoa, and helminthes. The following table presents the results of lab analysis, and the comparisons against Law 48, MOHP newly-issued Standards, and WHO 1989 Standards.

As shown in the table, TDS, BOD, COD, and Fecal Coliform along the Salaam Canal were within the tolerable levels for irrigation use. TDS showed an increase trend from 242 ppm at Domietta to 1,048 ppm after Serw, 1,141 ppm after Hadous, and 514 ppm at the Grand Siphon. BOD at Domietta was 10 mg/l, it reached 17.5 mg/l and 22 mg/l respectively after mixing with Serw and Hadous drains, and dropped to 14 mg/l at the Grand Siphon. The low COD/BOD ratios of 2.4-1.5 indicated limited industrial wastewater effect. Fecal Coliform counts in the three monitored drains were high, but the counts of the Salaam Canal itself, 4.500 at the beginning, 200 in the middle, and 900 at the end, remained within the levels of Law 48, or even partially satisfied the WHO 1989 Standards. The lowered Fecal Coliform counts at the Grand Siphon may be because of the long distance travelling of the water in the canal. In terms of conventional water quality indicators, the water of Salaam Canal at the Grand Siphon is almost as good as the water at Domietta intake point. A saying of Salaam Canal transferring pollution to Sinai seems lacking of evidence base.

On the other side, however, the large numbers of intestinal helminth eggs in the Salaam water desire a greater concern. All samples contained exceedingly high helminth egg counts compared to MOHP new Standards and WHO 1989 Standards. The water was heavily contaminated by Ascaris, Taenia, Hookworms, and Hymenolepis diminuta. Only 1 intestinal egg per 100 ml is allowable in 1989 WHO Standards, but 28 Ascaris eggs per 100 ml and even 720 Ascaris eggs per 100 ml were checked out at the Salaam end and after Hadous mixing respectively.

4. Health Protection Measures

The most effective and reliable strategy for preventing transmission of diseases caused by the use of wastewater is to treat the wastewater according to the proposed guidelines. However, such thorough treatment may be expensive.

The available measures for health protection can be grouped under four headings:

Treatment of wastewater, to meet the standard limits: protect the field workers, their families and the crop handlers.

Crop restriction *Crops can be broadly categorized according to the required extent of health protection measures applied to the water used:*

- Category A: Protection needed only for field workers. Includes industrial crops such as cotton, grains and forestry (commonly referred to as Restricted crops).
- Category B: Further measures may be needed. Applies to pasture, green fodder and tree crops and to fruit and vegetables that are cooked before eating.
- Category C: Unrestricted, i.e., the water is treated to the standard at which fresh vegetables and fruits can be eaten uncooked.

Crop restriction provides protection to consumers but not to farm workers and their families. Crop restriction is feasible and is facilitated in several circumstances, including the following:

- where strong low enforcement exists;
- where a public body controls allocation of the waste and has the legal authority to require that crop restriction be followed;
- where an irrigation project has strong central management;

- where there is adequate demand for the crops allowed under crop restriction, and where they fetch a reasonable price; and
- where there is little market pressure in favor of excluded crops.

In Egypt, crop restriction programs will be difficult to enforce except in very limited areas where the government has complete administrative control.

Control of effluent application Irrigation by flooding (generally used in Egypt) involves the least investment but probably the greatest risk to field workers. Subsurface irrigation provides the greatest degree of health protection as well as a more efficient use of water. However, it is expensive.

Human exposure control Exposure of field workers to hook worm infection can be reduced by use of appropriate footwear, adequate medical facilities, and treatment of nematode infection. Risks to consumers can be reduced by thorough cooking and by high standards of hygiene. Local residents should be fully informed of the location of all fields where human wastes are used. Sprinklers should not be used within 50–100 m of houses or roads. It is often desirable to apply a combination of several methods. For example, crop restriction may be sufficient to protect consumers but must be supplemented by additional measures to protect agricultural workers.

All above-mentioned health protection measures are difficult to apply in Egypt. The only effective and reliable strategy for preventing disease transmission caused by wastewater use is to treat the wastewater according to the suggested guidelines.

Wastewater Treatment

The most effective and reliable strategy for preventing transmission of diseases caused by the use of human wastewater is to treat the wastes according to the World Health Organization (WHO) standards. If this is done, disease transmission risk is reduced.

Raw wastewater contains $10^7 – 10^9$ fecal coliforms per 100 ml. The conventional treatment processes, including plain sedimentation, activated sludge, biofiltration, aerated lagoons, and oxidation ditches, will not, unless supplemented by disinfection, produce an effluent that complies with WHO guidelines for bacterial quality (<1,000 counts/100ml). Conventional wastewater treatment systems are not generally effective for removal of helminth eggs. There is a need for improving the efficiency of helminth egg removal, through means such as lime treatment, chemical coagulation and sedimentation, and sand filtration.

Waste stabilization ponds are usually the treatment method of choice in warm climates. They should be arranged in a series of anaerobic, facultative, and maturation ponds with an overall water retention time of 10 – 50 days, depending on the design temperature and the effluent quality required. The high degree of confidence with which pond series can produce effluents meeting WHO standards is only one of the many advantages of pond systems. Others include:

- low costs for construction, operation and maintenance;
- ease of operation and maintenance; and
- applicability to a wide variety of industrial and agricultural wastes.

6. Sludge Reuse in Agriculture

There is ample evidence that excreta, especially in developing countries, contains high concentrations of pathogens, and that many of these pathogens can survive for some time and can also withstand most conventional treatment processes. Almost all excreted pathogens can survive in soil and ponds for a sufficient length of time to pose potential risks to farm and pond workers. Pathogen survival on crop surfaces is much shorter than in soil, as the pathogens are less protected from the harsh effects of sunlight and desiccation. In some cases, however, survival times can be long enough to pose potential risks to crop handlers and consumers, especially when they exceed the length of crop growing cycles.

The conclusions of the reviewed epidemiological literature on the transmission of diseases associated with the fertilization of crops with excreta can be summarized as follows:

- ***Crop fertilization with raw excreta causes excess infection with intestinal nematodes in both consumers and field workers.***
- ***There is evidence that sludge treatment reduces the transmission of nematode infection.***
- ***The fertilization of rice paddies with sludge may lead to excess schistosomiasis infection among rice farmers.***

In Egypt farmers usually apply livestock manure to land manually. Laborers handling the sludge are the most exposed individuals to the human pathogens contained in sludge and are therefore at greatest risk of enteric disease. Under these circumstances the only reasonable and appropriate course of action is for the operator of the wastewater treatment plant to supply the farmer with a product that is sanitized and safe for unrestricted use on farm land.

To achieve the guideline for helminthic quality (<1 viable intestinal nematode egg per 100 g), the sludge to be treated must be stored for a period of at least a year at ambient temperatures. This period of storage refers to the whole time interval between excretion and land application, and so includes any time spent in a latrine pit, for example, or in a treatment process, such as an anaerobic digester or a composting plant. This storage period may be reduced by treatment at a higher temperature. Anaerobic composting of sludge has several additional advantages:

- ***It avoids the nuisance of odor and flies associated with the storage and application to the land of raw excreta.***
- It conserves nutrients.
- Mature compost helps to control plant pathogens.
- Mature compost holds moisture and thus minimizes groundwater pollution, especially by nitrates.

Sewage sludge always contains heavy metals, even if of entirely domestic origin. Heavy metals occur as a normal constituent of all types of foodstuffs and are present in human feces. The other source of heavy metals in sludge from direct discharges by industry connected to the sewer.

Once applied to the soil matrix, heavy metals are present indefinitely in the cultivated layers. Therefore, materials applied to the soil containing more of a particular lement than the soil itself will cause the soil concentration to gradually increase.

The quantity of sludge produced by wastewater treatment plants in Egypt is currently estimated to be about 950,000 tons of dry solids per year. Production will increase to 2,000,000 tons of dry solids per year by 2020, as the treatment facilities continue to be upgraded and expanded. This large amount of sludge requires effective management and safe disposal.

Disposal routes must be environmentally and socially acceptable and be cost-effective. Agriculture is the only outlet with an identified benefit from recycling the nutrients and organic matter contained in sludge. Consequently sludge should be regarded as a natural resource to be conserved and reused, rather than discarded. Its use in agriculture is widely regarded as the best practicable environmental option and the most sustainable outlet. It is also usually the lowest cost route and can provide income through the sale of treated sludge products. The fertilizer and organic matter contents of sludge offer resource and energy conservation and maintenance of soil fertility.

Cairo wastewater treatment plants There are three production areas in Cairo.

East Bank

	Shobra El Khiema WWTP	Berka WWTP	El Gabal El Asfar WWTP
Capacity in m^3/day	600,000	600,000	1,000,000
Type of treatment	Primary	Secondary	Secondary
Type of sludge	Primary	Secondary	Secondary
Type of sludge treatment	Sludge is currently air dried on two areas of temporary drying beds. It is transported on site by CGOSD. In the future, it will be pumped to El Gabal El Asfar for treatment.		It will begin operation for sludge facilities (thickening, digestion and mechanical de-watering).

Note: WWTP means wastewater treatment plant.

West Bank

	Zenein WWTP	Abu Rawash WWTP
Capacity in m^3/day	330,000	400,000
Type of treatment	Secondary	Primary
Type of sludge	Secondary	Primary
Type of sludge treatment	The liquid sludge from Zenien is pumped to Abu Rawash, and then is pumped to lagoons at km.54 on the Alexandria Desert Road.	

Note: The sludge from lagoons has low concentration of pathogens due to the greater ultra violet exposure and desiccation.

Helwan

The Helwan wastewater treatment plant has a capacity of 350,000 m^3/day and provides primary and secondary treatment. Liquid sludge drying beds were very poorly designed and are very inefficient. The sludge thickeners are not operating so the sludge is sold by CGOSD as soon as it dries.

Alexandria

The sludge from eastern and western Alexandria wastewater treatment plants is pumped to a mechanical de-watering site. The dry sludge is then transported to Ammrieya site for composting treatment, then it is packed and sold to farmers and contractors.

Other Governorates

In most cases the primary sludge is added to the excess of secondary sludge and the mixture is subjected to thickening. It is then transferred to drying beds, and it sold to farmers for reuse. Theoretically, it should be kept for six months in the drying beds. However, it is being sold to the farmers after 2-3 months, without being completely dry. Ultimate disposal practice is for land conditioning and fertilization.

5. Water Quality Standards

WHO Guidelines

In an effort to produce health guidelines for the reuse of wastewater in agriculture / irrigation, a group of experts from WHO, UNDP, UNEP, the World Bank and the FAO met in Engelberg Switzerland in July, 1985, and reviewed the existing practices and standards for wastewater irrigation and epidemiological studies in developing countries. The group concluded that the danger of infection was:

- high concerning intestinal nematodes;
- moderate concerning bacterial infections and diarrhea;
- minimal concerning viral infections and diarrhea and hepatitis A; and
- high to nonexistent concerning trematode and cestode infections, schistomiasis, and taenias, depending on local practices and circumstances

Using the findings, the group developed new quality guidelines for irrigation water (the Engelberg standards). These Guidelines were then modified at a WHO scientific group meeting in Geneva in November 1987. The group recommended their adoption as new WHO health guidelines for the use of wastewater in agriculture and aquaculture (WHO 1989). Table 1 shows the recommended microbiological quality of this standard.

Recommended Microbiological Quality Guidelines for Wastewater Use in Agriculture

Category	Reuse conditions	Group exposed	Intestinal nematodes[a] (arithmetic mean no. of eggs per liter[b])	Fecal coliforms (geometric mean no. per 100 ml[b])	Wastewater treatment expected to achieve required microbiological quality
A.	Irrigation of crops likely to be eaten uncooked; sports fields, public parks[c]	Workers, consumers, public	**⦸ 1**	**⦸ 1,000[c]**	Series of stabilization ponds designed to achieve the microbiological quality indicated, or equivalent treatment
B.	Irrigation of cereal, industrial and fodder crops; and pasture and trees[e]	Workers	**⦸ 1**	No standard recommended	Retention in stabilization ponds for 8-10 days for equivalent helminth and fecal coliform removal
C.	Localized irrigation category B crops if worker and public exposure does not occur	None	N/A	N/A	Pretreatment as required by irrigation technology, but not less than primary sedimentation

Source: WHO (1989)

In specific cases, local epidemiological, sociocultural, and environmental factors should be taken into account, and the guidelines modified accordingly.

a) *Ascaris* and T*richuris* species, and hookworms.
b) During the irrigation period.
c) A more stringent guideline (= 200 fecal coliforms per 100 ml) is appropriate for public lawns, such as hotel lawns, with which public may come into direct contact.
d) In the case of fruit trees, irrigation should cease two weeks before fruit is picked, and no fruit should be picked off the ground. Sprinkler irrigation should not be used.

The most important indicators of suitability of wastewater reuse are the intestinal nematodes and fecal colifroms. The guidelines depend on the reuse conditions and accordingly are divided into three categories:

- Category A: direct contact between the crop, water, workers, consumers, and public.
- Category B: direct contact is only between the workers and the water or soil.
- Category C: there is no contact between workers and water and soil (such as with forests).

The only wastewater treatment method noted in the guidelines which satisfies the criteria for categories A and B is the wastewater stabilization pond system. In the guidelines, consideration is given to the fact that in many developing countries the main health risks associated with wastewater reuse originate from helminthic diseases, and that the safe reuse of wastewater in agriculture should therefore require a high degree of helminth removal (helminth eggs in effluents <= 1/liter).

The second quality criterion specified in the health guidelines is the maximun acceptable limit on bacterial content of the effluent. A bacterial guideline of a geometric mean of 1000 fecal coliforms (FC) per 100 ml for unrestricted irrigation of all crops is recommended. Earlier WHO guidelines recommended a bacterial concentration of 100 FC/100 ml for unrestricted irrigation with wastewater effluents which were very restrictive.

The new guidelines regarding FC levels were justified by the following:

- Field and lab studies indicated that effluents with 1000 FC / 100 ml contained few, if any, detectable pathogens.
- In about 45% of rivers in the world, FC concentrations are ≥ 1000 /100 ml while 15% had FC levels ≥ 10,000/100 ml.
- The US EPA, together with the Academy of Sciences, recommended a bacterial guideline value of 1000 FC/100 ml for irrigation with surface waters.
- Bacterial guidelines and standards for bathing water quality developed by the Mediterranean Pollution Monitoring Programs of UNEP/WHO recommends 1000 FC/100 ml.

Egyptian Regulations

Below are the Egyptian laws and regulations related to wastewater reuse.

Law 93/1962

This law concerns wastewater disposal. It regulates the authority of the Ministry of Housing to construct public sewage systems and to prohibit or permit the discharge of fluid wastes into public sewers and/or on surface lands. Wastewater standards and specifications, decreed by the Ministry of Housing, must have the approval of the Ministry of Health.

Decree 649/1962 and Decree 9/1989

Decree 649/1962 of the Ministry of Housing, which is the executive regulations of law 93/1962, was supplemented and modified by Decree 9/1989. It sets the conditions and criteria set for wastewater disposal on surface areas distinguished between sandy soils and clay silt soils.

The relevant and important stipulations follow:

- The land should be situated more than 3 km from urban or rural built-up areas.
- The degree of purification should not be less than primary treatment.
- It is forbidden to grow vegetables, fruits or crops that are eaten raw and to raise animals or milk cattle on the lands irrigated with wastewater.

Amendments to the standards of law 93/1962 were developed by the Ministry of Irrigation and the Ministry of Agriculture, then reviewed and approved by the Ministry of Health (Supreme Committee for Water) in June 1995. However, they have not been issued yet by the Minister of Housing. According to these amendments, wastewater that is treated by primary treatment may be used in cultivating timber trees only. Wastewater that is treated by secondary treatment may beused in the cultivation of palm trees, cotton flax, jute, cereal, forage crops, field crops and nut fruits, flower nurseries, and thermally processed vegetables and fruits. According to these standards, only the tertiary treated effluent can be used for cultivation of uncooked eaten plants and vegetables, as the water in this advanced type of treatment is free from all types of pathogens.

Minister of Housing Decree No. 44/2000

This decree concerns the new executive regulation for law No 93/1962. According to Article 15 of this regulation, wastewater use in agriculture must meet the following criteria:

- Wastewater is defined as the wastewater effluent of treatment plants of domestic wastewater and industrial waste.
- The wastewater must undergo at least primary treatment to be reused in agriculture.
- The land irrigated by wastewater must be at least ___ kilometers away from villages or cities. It must be permitted by the Egyptian Environmental Affairs Agency (EEAA) and supervised by the Ministry of Health and Population.
- The standards of wastewater include limits on COD, BOD, T.S.S, oil and grease, Boron, and heavy metals. For the first time in Egypt, the standards include limits for Nematode eggs of 5/liter for the primarily treated effluent and 1/liter for secondary and advanced treatment levels.

According to the guidelines, crops can be grouped into three categories with regard to the degree of health protection measures required:

- Category A: Localized irrigation preventing the exposure of workers and consumers, primary treated effluent, and only trees and forestry permitted.
- ***Category B: Protection needed for field workers. Crops include industrial crops such as cotton, sisal, grains, vegetables which need cooking before being eaten, processed fruits, and flowers.***
- ***Category C: Advanced treatment for unrestricted irrigation. This category covers fresh vegetables, fruits and lawns.***

Law 48 / 1982

Law 48 concerns the protection of the Nile and its waterways against pollution. Decree 8/1983 by the Minister of Irrigation is the executive regulations of the Law. Law 48 prohibits discharges to the Nile, canals, drains and groundwater without a license issued by the Ministry of Public Works and Water Resources. Licenses are issued to factories, sanitary sewage treatment plants and riverboats, upon request, as long as the effluent meets certain standards and conditions. Licenses may be withdrawn under several conditions including failure to immediately reduce a discharge presenting pollution danger or failure to apply treatment schemes that yield appropriate effluent quality within three months.

The law gives the Ministry of Water Resources and Irrigation (MWRI) administrative and police authority over implementation. The Ministry of Interior's Water-Surfaces Police also has police powers, and the Ministry of Health has the role of setting standards and monitoring discharge.

Water quality standards are specified for the following categories:

- **Nile river,**
- **industrial discharges to the Nile and canals,**
- **treated industrial and sanitary water discharge to drains, lakes and ponds,**
- **treated discharge from river vessels to the Nile and canals, and**
- **drain waters to be mixed with the Nile or canals.**

Law No 12 / 1984
This law names the Ministry of Water Resources and Irrigation as the guardian of all water resources. It also regulates the authority of the Ministry to allocate irrigation water and to construct drainage systems. According to this law, the drainage of waters to public canals cannot be done without the Ministry's permission.

6. Inter-Ministry Cooperation in Wastewater Irrigation

Monitoring Programs

The Ministry of Health and Population laboratories are responsible for checking the quality of the effluent from the sewage treatment plants. The laboratories are equipped to perform all of the chemical and bacteriological analysis as needed by the standards included in the laws (48/1982 and 93/1962), except for parasitic infestation.

The Environmental Monitoring and Occupational Health Center (MOHP) laboratories are in charge of checking the water quality of the Nile and the main canals. The laboratories are capable of performing the analysis including those for heavy metals and pesticides residues in addition to bacteriological analysis of fecal pollution indicators.

Agricultural reuse and disposal of wastewater in Egypt is an activity in which several ministries and a variety of semi-autonomous authorities and segregated entities have an interest. The main governmental bodies and supporting institutions are:

- The Ministry of Agriculture and Land Reclamation
- The Ministry of Housing Utilities and Urban Communities
- The Ministry of Health and Population
- The Ministry of Water Resources and Irrigation
- The Ministry of Environment and the Egyptian Environmental Affairs Agency
- Scientific Institutions and universities

The Ministry of Agriculture and Land Reclamation (MALR)
MALR initiates and implements most of the policies related to the agricultural sector. It guides farm production, sets quotas on areas allocated to various crops, regulates crop rotations and is responsible for agro-economic research, and demonstration of new technologies.

The Ministry of Housing Utilities and Urban Communities (MHUUC)
The General Organization for Sanitary Drainage in Cairo (GOSD), the Alexandria General Organization for Sanitary Drainage (AGOSD), and the National Organization

for Potable Water and Sanitary Drainage (NOPWASD) are major organizations within the Ministry of Housing that are responsible for planning and constructing municipal wastewater treatment plants.

The Ministry of Health and Population (MOHP)
The MOHP has been given a central role in water quality management, especially in setting standards of water for the quality of:

- potable water resources (River Nile and Canals),
- drain waters that can be mixed with other waters for drinking,
- industrial and sewage treatment plant discharges, and
- wastes discharged from river vessels.

The MOHP is also responsible for sampling and analysis of all wastewater discharge and for checking the wastewater quality. It also has an advisory role in hygienic health education and disease surveillance and treatment.

The Ministry of Water Resources and Irrigation (MWRI)
The MWRI is responsible for the development of water resources and for the operation and maintenance of irrigation and drainage systems. It is the only body that can authorize the taking of water from the Nile Basin, the use of groundwater from the Nile Valley and the reuse of drainage water for irrigation. It allocates water for reclamation areas, decides upon division of water supply between areas, and administers the rotation system for irrigation.

As the custodian of the country's water resource, the MWRI is also concerned with maintaining water quality. The MWRI has delegated these tasks to the National Water Research Center, which consists of the following institutes:

- Drainage Research Institute
- Nile Research Institute
- Research Institute for Groundwater

The Ministry of Environment and the Egyptian Environmental Affairs Agency (EEAA)
The Egyptian Environmental Affairs Agency, which is charged with the protection and promotion of the environment, was established by Law 4/1994 within the Prime Minister's cabinet. It has a public juridical personality and is affiliated with the Minister of Environmental Affairs. The EEAA is responsible for setting national policy for the environment and coordinating environmental management activities within the government.

The Board of Directors of the Egyptian Environmental Affairs Agency is chaired by the Minister for Environmental Affairs. The Board of Directors is the supreme authority that governs the affairs of the agency and makes its general policy. Decisions are made by the majority of members attending a meeting. The chairman casts the deciding vote if the votes are equally divided.

Scientific Institutions and Universities
In terms of supporting institutions, Egypt benefits from having a number of scientific institutes with research capabilities such as the Academy for Scientific Research and Technology; the National Research Center; the National Water Research Center; the Soil,

Water and Environment Research Institute; and the National Institute for Oceanography and Fisheries Research. There are also a number of universities with good environmental science and engineering programs such as Ain Shams and Cairo and Alexandria Universities. These institutions carry out basic and applied research on water quality management issues.

7. Problems and Constraints

An analysis of the specific features of water quality management indicates the following problems:

- *Unclear responsibilities and lack of coordination*: Management of pollution in Egypt is rather fragmented. Ministries have responsibilities for certain aspects, but there is no overall coordination. The result is that, while prevention, treatment and impact mitigating measures are being applied, they are not implemented on the basis of a common and coordinated set of priorities.
- *Lack of enforcement*: At present there is limited capacity within the government to enforce the regulations dealing with water quality, especially regarding government enterprises that pollute.
- *Insufficient willingness* at all levels of society to bear the consequences of the implementation of the laws.
- *Limited financial resources* allocated to implement measures to comply with the law (e.g. construction of treatment plants).
- *Lack of information*: There is a need for more information about pollution sources and for an exact situation analysis.
- *Lack of awareness and knowledge* about pollution and its consequences and management.

Suggested Immediate Actions

- Treat liquid hazardous waste at the source.
- Develop detailed plans for sludge management.
- Develop a legal framework and executive regulations for private enterprises that will participate in the sludge management system.
- Maximize the local manufacturing of equipment used in sludge treatment and transportation facilities.
- Review the proper technologies for sewage disposal treatment, such as anaerobic fermentation, in some wastewater treatment plants relying on local expertise.
- Train the officials responsible for management of sewage treatment in the different stages.
- Develop a reliable and updated database of quantities and criteria of the sludge as a product of wastewater treatment.
- Attend to the urgent rehabilitation requirements for sewage treatment plants.
- Conduct the relevant studies such as pilot economic, technical and market studies necessary for the proper management, utilization and distribution of the treated wastewater.

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APRP - Water Policy Activity
Contract PCE-I-00-96-00002-00
Task Order 807

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 34, Appendix 3
Wastewater Irrigation for Forest Plantation

November 2000

Water Policy Program
International Resources Group Winrock International Nile Consultants

Task Order No. 807
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Report No. 34

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Appendix 3

Wastewater Irrigation for Forest Plantation

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Ministry of Agriculture and Land Reclamation

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For
United States Agency for International Development / Egypt

Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)
Partners: *International Resources Group, Winrock International, and Harvard Institute for International Development*
Subcontractors: *PADCO; Management Systems International; and Development Alternatives, Inc.*
Collaborating Institutions: *Center for Naval Analysis Corporation; Conservation International; KNB Engineering and Applied Sciences, Inc..; Keller-Bliesner Engineering; Resource Management International, Inc.;*

Tellus Institute; Urban Institute; and World Resources Institute.

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1. Introduction

Egypt is an arid country with a population of about 65 million people. It is estimated that Egypt adds one million new citizens every nine months. This high rate of population growth is expected to continue for many years to come. Most of the population lives within a narrow band corresponding approximately to the width of the Nile River valley. The population growth and high density of people along the Nile puts an incredible strain on the delicate Nile water resource. Agricultural development has always been, and still is today, closely associated with the Nile water. Almost 84% of Nile water are consumed by the agricultural sector, while eight, five, and three percent are allocated for industrial, municipal and navigation uses respectively.

Egypt's annual water resources include:

- *55.5 bcm of Nile freshwater released from the High Aswan Dam,*
- *5.5 bcm of pumped groundwater,*
- *100-200 mm of rainfall, only in the northern shore area,*
- *4.5 bcm of official and 2.5 bcm of unofficial reuse of agricultural drainage water in the Delta, and*
- *2.3 bcm of treated urban sewage as shown in the following table.*

Table 1, Treated Urban Sewage in 1998 in Egypt

Locations	***(mcm/day)***
Greater Cairo	*4,130*
Alexandria	*317*
Upper Egypt	*99*
Lower Egypt	*955*
Middle Egypt	*170*
Suez Canal	*410*
Sinai	*81*
New Valley & Matroh	*47*
Total	***6,209*** *(2.3 bcm/year)*

Source: NOPWASD, "Appendix 1, Wastewater Treatment in Egypt," in "National Policy for Urban Wastewater Discharge and Reuse," MWRI/EPIQ water policy benchmark C2 report, July 2000.

The quality of treated wastewater differs from one treatment station to another, depending on inflow quality, treatment level, plant operation efficiency, and other factors. The following tables present the effluent quality of the Ismailia and Sadat wastewater treatment plants. The Ismailia treatment plant receives only urban domestic wastewater, while the inflow of Sadat treatment plant includes some portion of industrial wastewater.

Table 2, Effluents Quality of Ismalia and Sadat Wastewater Treatment Plants

PARAMETERS	***MONITORED RESULTS***	
	ISMALIA CITY	*SADAT CITY*
PH	*7.7*	*8.2*
EC MMOI/CM	*1.1*	*1.3*
TDS PPM	*729*	*645*
NA PPM	*69.4*	*121*
K PPM	*21*	*32*
CA PPM	*48*	*53*
MG PPM	*26*	
CO3 PPM	*55*	*55*
HCO3 PPM	*366*	*437*
CI PPM	*185*	*220*
N PPM	*19.9*	*26.2*
P PPM	*5.2*	*9.4*
SODIUM ABSORPTION RATE (SAR)		
ADJUSTED ABSORPTION RATE (ADJ. SAR)	*5.5*	*8.13*

Sources: Ismalia and Sadat wastewater treatment plants, 1999.

The table reports higher EC & PH values (or higher alkalinity and element concentration) of Sadat plant effluent. These are verified by the slower growth rate of trees planted on the Sadat site. Compared to the trees irrigated by freshwater either in Ismailia or Sadat, however, the wastewater-irrigated trees are notably healthier, grow faster as easily observed in the fields.

2. Sustainable Reuse of Wastewater Effluents: Forest Plantation

MALR Policy

The Ministry of Agriculture and Land Reclamation (MALR) has a clear policy for the reuse of wastewater effluents: *Use the wastewater effluents for irrigating and producing timber trees planted in the desert, and never use the water for irrigating any other crops like fruits, vegetables, and field crops.*

The rationale for this policy includes the following:

- Egypt’s timber resources need bolstering, as there are no natural forests in Egypt due to the lack of rainfall.
- Egypt is currently exporting some fruit and vegetable crops abroad, and the use of effluent water in irrigating such crops would prevent it from competing with similar crops produced by neighboring countries.
- While treatments are expected to improve during the coming few years, most sewage water treatment stations in Egypt currently have only primary or second treatment facilities. Thus, only in due time and with the availability of new facilities could effluent

water be used for purposes such as the production of ornamental plants, cut flowers and fiber crops.

- Egypt's current water needs are not critical enough to necessitate use of the effluent water in sensitive crops such as fruits, vegetables, etc.

MALR is implementing its sewage reuse policies, as shown the communication letters issued by the Minister on a wastewater reuse case in October 6 City, in Annexes 1-3.

MALR suggests the following formula for the reuse of wastewater effluents:

WASTE WATER	+	***WASTE LAND***	=	***GREEN TREES***
(treated sewage)		*(sandy desert soil)*		*(Forest Plantation)*

The wastewater-irrigated forest plantation was started five years ago in Luxor on 100 feddans of desert sandy soil, right behind the main sewage station of Luxor City. Initially, 40 feddans of the land were planted with the following tree varieties: Eucalyptus, Casuarina, Acacia, Mulberry (Morus Japonica, and Alba), Khaya and Caprrisus. The area was irrigated with treated sewage water from the nearby treatment station in flood irrigation system.

Eighteen months later, the pioneer experiment was evaluated. Some tree varieties were growing fast, specifically Eucalyptus, Acacia, Mulberry and Khaya. That promising outcome encouraged expansion of the area to 150 feddans of Khaya trees (African Mahogany) in a modified flood irrigation system.

Five years later, the results become astonishing -- way beyond the most optimistic predictions: the trees exceeded 4.5 meters in height, and the tree's green crown coverage reached 16 square meters. The trees were only irrigated with treated sewage without any other chemical or mineral fertilizers.

Photos 1-5 include a collection of the activities carried out in wastewater-irrigated forest plantation in Luxor, Ismalia, and other pilot sites.

Pilot Projects

Active pilot wastewater-irrigated forest projects are listed in Table 3 below. It is worth mentioning that all these forests were developed in the past five years, and they are all exclusively irrigated by wastewater effluents.

Table 3, Wastewater-irrigated Forest Plantation Pilot Projects in Egypt

Site Names	***Area*** *(feddans)*	***Planted Trees***	***Soils***	***Irrigation Methods***
1) Ismalia	*500*	*Caprrisus and Pinus*	*Desert sandy*	*Drip*
2) Sada	*500*	*Cuprrisus, Mulberry, and Pinus*	*Desert sandy*	*Drip*
3) Luxor (close to airport)	*1,000 (including a nursery for Mahogany seedlings)*	*African Mahogany (Khaya)*	*Desert sandy*	*Modified flood (a new area uses drip irrigation)*
4) Qena	*500*	*Eucalyptus and Mahogany*	*Desert sandy*	*Modified flood*
5) Edfu	*500*	*African Mahogany*	*Desert sandy*	*Modified flood*
6) New Valley (El Kharga)	*800*	*Eucalyptus, African Mahogany, and Terminalia*	*Desert sandy*	*Modified flood*
7) New Valley (Paris)	*50*	*African Mahogany*	*Desert sandy*	*Modified flood*
8) South Sinai	*200*	*Acacia and Eucalyptus*	*Desert sandy*	*Drip*
9) Abu Rawash	*50*	*Experiment of Neem trees (controlling for insects)*	*Desert sandy*	*Modified flood*

Economic Assessment

Whether wastewater-irrigated forests can be profitable and attractive to private sector investors is an important issue. After five years of research and experiment on pilot sites, we would like to confirm the following conclusions:

- *Wastewater effluents are free-of-charge, always available for use. The water provides a sustainable irrigation source for forest plantation.*
- *The lands used in forest plantation are desert sandy soils. Such lands can be sold or leased by the Government at low prices.*
- *The tree varieties selected in pilot sites have excellent economic value in timber production. For example, Cuprrisus starts wood production 10-12 years after planting, and frican Mahogany starts timber production in 15-25 years of plantation.*
- *Inter-cropping other crops with trees are approved fully possible, which helps obtain faster economic returns. Such crops include ornamental plants, cut flowers, and mulberry shrubs (for rearing silk-worms and enhancing siri-cultural products).*

There is great potential of forest plantation with satisfactory economic returns in Egypt, both in short-term and long-term. Costs and profits in different plantation scenarios are examined in the following tables.

Table 4, Cost of reclaiming and planning one feddan with timber trees (Cuprrisus), and irrigating it with treated sewage water in one year.

ITEM	COST IN LE
One feddan desert land	400
Road–paving	500
Installation of a drip-irrigation network, including both filters and pumping stations	3,500
400 Cuprrisus seedlings + 50 patching seedlings at the price of one Egyptian pound per seedling.	450
Labor year-round (irrigation and service)	540
Irrigation process year-round, using diesel	1,440
TOTAL per feddan	6,830

Table 5, Cost of reclaiming and planting one feddan with timber trees (Cuprrisus), and irrigating it with treated sewage water in twelve years

ITEM	COST IN LE
One feddan desert land	400
Road–paving	500
Installation of the irrigation system	3,500
Irrigation network maintenance	540
Cuprrisus seedlings	450
Labor (irrigation + service)	6,480
Irrigation process	17,280
TOTAL	29,150

No. of produced trees after 12 years would be:
400 trees X ½ M^3 wood X L.E. 800/meter + L.E. 1,600

Table 6, Cost of planting one feddan with Ponsiana trees intercropped with Cuprrisus timber trees at 3x 3 meter spacing intervals in two years

ITEM	COST IN LE
Land service and planting	500
5 Kg. Ponsiana seed	50
Labor	500
Irrigation process	1,000
Pruning process	500
Installation of irrigation system	2,000
TOTAL	4,550

No. of produced seedlings after two years is 1000 seedlings
Average sale price per seedling is L.E. 12
Total sale price is L.E. 12,000

Table 7, Cost of planting one feddan with ornamental trees (Perisharuia palms) inter-cropped with timber trees (Cuprrisus) at 3 x 3 meter spacing intervals in three years

ITEM	COST IN LE
Land service and planting	500
1000 seedlings	300
Labour	1,000
Irrigation	1,500
Irrigation system	2,000
Harvesting	1,000
TOTAL	6,300

No. of produced seedlings after two years is 1000 seedlings
Average sale price per seedling is L.E. 20. Total sale price is L.E. 20,000

First Case

- The cost of planting one feddan with Cupprisus for 12 years is L.E. 29,150
- The return revenue from produced wood after 12 years is L.E. 160,000

Net Profit = L.E. 130,850

Second Case

- The cost of planting one feddan with Cuprrisus for 12 years is L.E. 29,150
- *The cost of planting Ponsiana trees intercropped on Cuprrisus trees for 12 years is L.E. 27, 300*

Total Cost = L.E. 56,450
Total revenue from woods is L.E. 160,000
Total revenue from ponsiana is L.E. 48,000
Total Revenue (Profit) is L.E. 208,000
Net Profit after 12 years = 208,000- 56,450 = L.E. 151,550

Third Case

- Cost of planting one feddan with Cuprrisus for 12 years is L.E. 29,150
- *Cost of planting Perishardia palms intercropped with Cuprrisus for 12 years is L.E. 25,200*

Total cost is L.E. 54,350
Total return from woods is L.E. 160,000
Total return from Perishardia L.E. 80,000
Total return (revenue) L.E 240,000.
Net Profit in 12 years = 240,000 - 54,350 = L.E. 185,650

Table 8, Net Profit per Feddan in the Short and Long Term

Item	Cost in 12 years (L.E.)	Revenue in 12 years (L.E.)	Net profit in 12 years (L.E.)
1) Long term in case of Cuprrisus only	29,150	160,000	130,850
2) Short and long term in case of Cuprrisus with Ponsiana.	56,450	208,000	151,550
3) Short and long term in case of Cuprrisus with Perishauria.	54,350	240,000	185,650

Impact on Groundwater Aquifer

Where treated sewage is used to irrigate timber trees in desert sandy soils on our pilot sites, there should not be any fear on the water level or pollution of groundwater aquifer based upon the following reasons:

- *The sites all have the groundwater depth of 50-200 meters or more.*
- *Even if some of the irrigation reached the groundwater aquifer, it must have been filted, and therefore, purified, by the thick sand layer of 50-200 meters. This is exactly what people are doing at the Tel Aviv Sewage Treatment Station, Israel, where sewage water, after treatment, is re-charged to the sandy soils for raising groundwater level in the deserts.*

Treated sewage water here refers to the treatment plant effluents from municipal but not industrial areas.

Forest Plantation in the Delta

There is much justification for wastewater-irrigated forest plantation on desert sandy soils. But such plantation is not suitable the Nile Delta region for the following reasons:

- *The fertile and expensive lands in the Delta are more needed for the nation's fruits, vegetable, and grain crop production. Forest is not the priority development goal for the Delta region.*
- *The depth of underground water level in some areas of the Delta is as thin of less than 1.5 meters. There is a higher risk of mixing wastewater with the valuable groundwater sources in the Delta region.*

The question now is what is the ideal use of the wastewater effluents in the Delta? Should it be suitable to use wastewater to irrigate fruit crops or vegetables in the Delta? MALR's answer is NO. An ideal choice would be to transmit the effluents to adjacent and neighboring deserts for forest plantation there. But a more realistic solution is to use the water for irrigation street trees or green belts in the cities. MALR considers it as fundamental that any devised reuse schemes not include wastewater irrigation on fruits and vegetables and not cause higher groundwater levels in the Delta region.

Another question of paramount importance is how much of the wastewater effluents the forest plantations can consume. The meaningfulness of the proposed wastewater reuse in forest plantation depends on the scale and amount of the wastewater to be absorbed by the forests. An indirect but eligible answer would be as follows: the effluent stations adjacent to the desert areas can be planted with forests if the effluent stations could be privatized, or if private investors could establish new stations near the deserts for the safe discharge of such water.

Mixing with Agricultural Drainage or Freshwater?

Some researchers and specialists advise mixing treated sewage water with agricultural drainage water or fresh water for reuse. There are also arguments to support the use of treated wastewater for certain fruits or orchards whose trees bear fruits far from the fround.

MALR does not support, in general, to use wastewater effluents irrigating any crops other than timber trees for the following reasons:

- *Most effluents are from* primary treatment, *which are necessarily qualified for fruits and vegetables eat raw.*
- *Mixing with drainage water or freshwater converts both fresh water and agricultural drainage into diluted treated sewage water. The microorganisms or microbes from sewage will be more propagated in the water or in the soil.*
- *The risk and/or hazards will be even greater if such wastewater is produced from industrial complexes or municipal-industrial mixed areas.*

Egyptian cotton is a well-recognized, high quality product in the world. MALR opposes wastewater irrigation on cotton for two main reasons:

- *Cottonseed is extracted for its oil, which is one of the major food-oil sources in Egypt.*
- *There is a possibility that the fibers produced from the cotton irrigated by such water might cause a skin allergy in sensitive skin types, which would badly affect the export market for Egyptian cotton.*

Outlook to the Future

Building on the experience of the pilot forest plantations, MALR agrees with the Agricultural Policy Reform Program (APRP) to establish a new policy for the Government to sell or lease desert lands adjacent to wastewater treatment plants to private investors for forest plantations. Private sectors can be profited in the business of wastewater safe discharge and reuse in forest plantations.

The use of sewage water to develop forests in deserts represents a challenge for the Undersecretary for Afforestation and Environment, MALR. Since the early 1990s, the Undersecretary, with support of donors and international agencies for development, has actively conducted many activities in promoting desert forest plantation with wastewater irrigation throughout Egypt to reduce the wood and timber imports (estimated at LE 3 billion per year). The benefits to the country are numerous. Wastewater irrigation on forests encourages desert land reclamation, conserves the valuable Nile freshwater for food or forage crops, and also, helps urban areas to reduce the burden of increasing sewage waters.

The Undersecretary for Afforestation and Environment is aware of all aspects and potentially contentious issues surrounding the use of wastewater: environmental protection issues, socio-economic benefits for the population, and effects on the country's economic development through the impact of water and soil pollution. Under the auspices of the Ministry of Agriculture and Land Reclamation, several workshops were organized, with the help of international organizations, to explore the leading experiments in the field of afforestation using wastewater. The participants at these workshops represented various sectors (public services, universities, research institutes, private sector, NGOs, and etc). The main issues discussed during these workshops were: use of sewage water for afforestation; tree-planting techniques and requirements; forestry, investment and research policies; and the role of the GOE and the private sector.

3. Inter-Ministry Cooperation in Wastewater Reuse

A well-conceived afforestation policy and tree-planting scheme are necessary if the objectives of sustainable forestry development and environmental protection are to be met. This means setting up sound ecological tree planting and plantation management techniques and creating incentives to encourage the involvement of farmers and private sector investors.

The policy should set the measures and criteria for using sewage water without harming the health of humans or animals, through coordination of MALR, MWRI, Ministry of Health and Population (MOHP, National Organization for Potable Water and Sanitary Drainage (NOPWASD), and Ministry of Environmental Affairs (MEA). The on-going activities under the APRP Water Policy Benchamrk C2 (urban wastewater discharge and reuse) have greatly contributed to the promotion of such inter-ministry cooperation.

The Ministry for Environmental Affairs, jointly with the United Nations Development Program (UNDP), held a Workshop in Cairo, on May 21, 2000, to update the National Plan for Environmental Work, under the title, "Declaration of the National Environmental Action Plan 2000". The workshop had five work groups to discuss two major issues: solid wastes and treated sewage waters. In the workshop, the Ministry of Agriculture and Land Reclamation pointed out that a nation-wide action to reuse treated sewage water for forest plantation has already been taken and led by MALR in several pilot areas in the nation.

4. Magic Water

"Magic water" may sound like a strange term; however, it seems appropriate following the establishment of forests irrigated by treated sewage water in various sites around Egypt, and under different climatic conditions. It was noticed, in all cases, that the growth of most tree varieties planted in such forest sites was very rapid and vigorous. This fact was confirmed with the Cuprrisus, Eucalyptus, African Mahogany (Khaya), and Acacia Saligina varieties.

The height of some Cuprrisus trees reached 2.5 meters in two years, while that of Khaya trees reached two meters in two years, and four meters in five years. Moreover, some of the Khaya trees started blossoming after five years of planting their seedlings in Luxor Forest. The diameter and the circumference of Eucalyptus trees planted in Luxor Forest reached 31 cm and 96.5 cm, respectively, in five years. The diameter and circumference of the Khaya trees planted in Luxor Forest reached 15 cm and 46 cm, respectively, in five years. Photos 6-10 include a collection of the achievements in wastewater-irrigated forest plantation in Luxor, Ismalia, and other pilot sites.

Research revealed that the vigorous growth and the very dark green color of the leaves is a direct reflection of the wastewater's high content of numerous macro and micro elements, in addition to organic materials. Yet, this answer is not convincing, considering that most of the fruit crops planted in sandy soils and drip-irrigated with fresh water, fortified with all nutritive elements either via injection into the irrigation system or direct spraying on leaves, didn't show the same level of growth attained by the trees irrigated by treated sewage water (provided that no fertilization or spraying with nutritive elements was done to the seedlings while in the nurseries -- they received treated wastewater exclusively).

Dr. Z. Zidan and S. Maximos mention in their book Pomology Orchards *that "Kogl et al were able in 1934 to extract IAA oxine, i.e., Indole Acetic Acid in its pure chemical forms from human- urine samples" (pg 431). Also, in the book, under the first seminar on growth regulators, (p. 20-47, 1972), it was mentioned that "the real discovery of the oxine (IAA) and knowing or identifying it goes back to the experiments and trials of Kogl et al, who were able to prepare it in the form of crystallized substance from human urine samples." This means that the trees planted in our pilot sites are being irrigated with a water containing growth regulators, particularly IAA oxine, which is the most important natural plant hormone found in all higher plants, and its formation sources are limited to the growth zones and the active tissues. Also, fruit embryos and seeds are considered among the most important sources for the production of plant hormones. In other words, we can say that treated sewage water contains:*

- *variable nutritive elements,*
- *organic materials, and*
- *plant growth regulators, such as IAA oxine, expediting plant growth rates.*

Wastewater is "magic" water. It creates adverse environmental consequences, but it also can greatly benefit the people if with proper treatment and reuse. Unrestricted use of wastewater in general agricultural irrigation sounds simple but is not a wise reuse scheme, given the various negative consequences. A fundamental issue is why not to use the magic water first for forest plantation in the deserts, for car washing, street tree or park irrigation in the cities so that the valuable Nile freshwater can be saved for vegetables, fruits, and agricultural crops.

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Agricultural Policy Reform Program
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POLICIES AND PROCEDURES FOR

IMPROVED URBAN WAStewater Discharge and Reuse

Report No. 34, Appendix 4
Industrial Wastewater Management

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Report No. 34

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Appendix 4

Industrial Wastewater Management

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Egyptian Environmental Affairs Agency

November 2000

For
United States Agency for International Development / Egypt

Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ)
Partners: *International Resources Group, Winrock International, and Harvard Institute for International Development*
Subcontractors: *PADCO; Management Systems International; and Development Alternatives, Inc.*
Collaborating Institutions: *Center for Naval Analysis Corporation; Conservation International; KNB Engineering and Applied Sciences, Inc..; Keller-Bliesner Engineering; Resource Management International, Inc.;*

Tellus Institute; Urban Institute; and World Resources Institute.

TABLE OF CONTENTS

1. Introduction

Due to limited fresh water resources and increasing demand for development, Egypt is facing the need for reusing water from agricultural drains and reducing the flow from drains to the sea. This calls for taking a serious look at the quality of Egypt's fresh and wastewater.

The socio-economic costs of poor water quality are enormous: almost 100,000 recorded deaths every year are due to water-borne diseases, with unrecorded figures several times higher. Over 2.4 million feddans of irrigated land suffer from salination; fishing output is reduced and generally decreases in value; and urban drinking water treatment becomes costly (1).

Egypt enjoys a good set of laws and regulations that govern wastewater, potable water, and seawater; in addition to the infamous Environmental Law #4 of 1994. For example, Law 48/1982 deals with the protection of the Nile from pollution, and delegates the responsibilities of monitoring the quality of the Nile and its branches to the Ministry of Water Resources and Irrigation (MWRI).

Egyptian industry, in general, is one of the major sources of water pollution. It uses 638 million cubic meters (mcm) per year of water, of which 549 mcm are discharged to the drainage system. The River Nile supplies 65% of the industrial water needs and receives more than 57% of its effluents. Industrial effluents usually contain pollutants of fluctuating concentrations. These pollutants are the main hindrance to effective drainage water reuse (1).

The main purpose of this report is to clarify the Ministry of Environmental Affairs' (MEA) policy vision and actions in controlling the discharge of industrial wastewater pollutants in agricultural drains in general, and in the Middle Delta and Eastern Delta regions in particular.

This report is composed of five sections. Following the introduction, the second section presents the accounts of the sources and characterization of industrial wastewater discharged to agricultural drains in the Middle Delta and the two drains feeding El Salaam canal. Section 3 presents the vision and policies of the MEA regarding industrial wastewater control. Section 4 describes the status of inter-ministry cooperation in industrial wastewater control.

2. Industrial Wastewater

Industrial development began in the Central and Eastern Delta region some seventy years ago, with a focus on the Gharbia Governorate, which is the axis between Alexandria and Suez, the two major sea ports. This report focuses on industrial wastewater in the Central Delta and Salaam canal regions.

Gharbia Governorate

Industrial wastewater discharges in Gharbia Governorate were detailed in reports developed by the Academy for Scientific Research, Ministry of Industries (MOI), Ministry of Health and Population (MOHP), and MWRI (1-5).

The Gharbia Governorate is a major industrial region in the Middle Delta. The region has more than 1,400 industrial plants, 60 of which are large and medium plants with average wastewater discharge of 500 - 35,000 m3/d.

The total water supply for industries in Gharbia Governorate is about 105 mcm per year, while the total industrial wastewater discharge in the Governorate is about 90 mcm. Industrial wastewater is discharged to many receiving bodies as follows:

- About 18 mcm to Rasheed branch and some canals.
- About 60 mcm to agricultural drains (48 mcm to the main Gharbia drain and drain # 5).
- About 1 mcm to the municipal sewage networks.
- About 1 mcm to the groundwater aquifer (4).

For large and medium industries, the average annual discharge rate is estimated at 52 mcm. Out of that, 10 mcm are discharged to the Nile, 36 mcm to canals and drains, and 6 mcm to municipal sewage networks. Clearly, agricultural drains receive the largest amount of industrial discharge (4). Twenty-five major plants were identified in the region. Nine of them discharge to drains with an estimated total annual discharge of 28 mcm. The following table identifies these major nine plants, their estimated annual discharges, and the receiving drains (4):

Name of Plant	Annual Discharge(m3/y)*	Receiving Drain
Misr for Spinning & Weaving	10,500,000	Gharbia Main # 5
Alex for Oils & Soap	5,400,000	Janah
Nasr for Spinning & Weaving	4,500,000	Gharbia Main # 5
Tanta for Oil & Soap	3,000,000	Gharbia Main # 5
Nasr for Dyeing & Finishing	2,100,000	Laeny
Tanta for Lenin & Oils	780,000	Mahalet Marhoom
Arab for Cotton	450,000	Batanonya
Suez for Petroleum	360,000	Mahalet Marhoom
Nasr for Garment	900,000	Private

* Calculated for annual 300 operational days.

The nature of industrial activities dictates the type of pollutants that are discharged. The following are the expected pollutant effects from various industries:

- increased organic loads and oils and grease from food, oil and soap, textile and finishing industries;
- increased pH due to washing and saponification;
- increased loads of heavy metals due to discharges from the huge dyeing industry in Al Mahalla Al Kobra, and the rubber industry in Tanta.

The table below presents the estimated daily loads of various pollutants discharged to Gharbia Governorate (2):

Pollutant	Daily Load (Ton/Day)
BOD	15
COD	31
Oil & Grease	18

Total Dissolved Solids (TDS)	161

And the industrial discharging load in the region is given in the table below.

Drain	BOD	COD	Oil & Grease	TDS	Heavy Metals
# 5	**5.4**	**9.6**	**5**	**50**	**0.15**
Mahallat Marhom	**0.4**	**2.2**	**1.2**	**11**	**0.02**
Janah	**2.2**	**3.0**	**2.6**	**3.0**	**0.03**
Batanony	**0.6**	**1.5**	**--**	**3.0**	**--**

Conclusion

From the available information and data, one can conclude that although waters of the agricultural drains are polluted from various sources, toxicity can be attributed mainly due to the industrial discharges. This fact was repeatedly asserted by many studies (1-6).

El Salaam Canal Region

The Egyptian Government is embarking on a national plan to develop certain areas outside the overcrowded Nile Valley. One of the main target areas is the northern region of the Sinai Peninsula. El Salaam canal project is intended to supply this region with water from the Valley.

There are three sources of water to feed El Salaam canal, namely:

- **Domietta Branch, which supplies the canal with 9 mcm/day**
- **Hadous drain, which supplies the canal with 5 mcm/day, to be increased to 7 mcm/day**
- **Serw drain, which supplies the canal with 2 mcm/day**

The total amount of industrial wastewater feeding into the Salaam canal through these sources is estimated at 170 mcm/year. Out of this, large plants contribute about 93 mcm/year.

These waters come to the drain through a group of secondary drains; mainly Bahr Tanah and El Bahr El Saghier. These secondary drains are the receiving bodies of the industrial discharge from 14 large industrial facilities located in the Dakahlia Governorate, east of the Domietta Branch. These plants discharge about 27 mcm annually -- 15 mcm of industrial discharge, 10 mcm cooling waters, and 2 mcm of domestic sewage (4).

The waters supplying Hadous drain originate from a series of secondary drains; mainly Hadous itself, Saft, Ramses, Bahr Sa'd, and Al-Shebeeny. These drains are the receiving bodies for the discharges of 12 large industrial facilities. These large plants discharge about 9 mcm/year of wastewater, (5 mcm industrial wastewater and 4 mcm cooling water), (4).

The Hadous drain also receives waters from another set of secondary drains that act as the receiving bodies for the industrial discharges of 35 plants in Shoubra El Khiema, located North of El Sharkaweya canal and West of the Tawfeeky Rayah. These plants discharge in the Fakous and Tera drains. Their estimated annual discharge is 58 mcm (31 mcm industrial wastewater, 25 mcm cooling water, and 2 mcm domestic sewage) (4).

The following are pollution load estimates in El Salaam canal after receiving waters from the three main sources -- the Domietta branch, Hadous and Serw drains:

Pollutant	Load (tons/day), (Ref.2)	MOH analysis, Mar 2000
BOD	35	22
COD	100	37
Oil & Grease	25	5
Suspended Solids	80	-
Total Dissolved Solids	160	1140

Conclusion

The water of El Salaam canal receives high loads of pollutants every day. However, through its long journey of about 180 km, most of the suspended matter, oils and grease are precipitated; in addition to the partial removal of COD and BOD. Due to this natural cleaning process, testing of the quality of the canal's waters before crossing of the Suez canal revealed a high degree of transparency.

The Environmental Health Department of MOHP is conducting a full-scale analytical study on the waters of El Salaam canal. The results of this study will shed more light on the quality of these waters, thereby helping in developing the policies and actions to be adopted in order to improve/preserve their quality.

MEA Priorities

The MEA adopted a policy aimed at improving the quality of waters feeding the El Salaam canal from the drains of the East Delta region and the reused drainage water in the Middle Delta region. This policy is based upon encouraging/forcing industrial facilities in these regions to control their industrial pollution. In fact, controlling major polluting plants in these two regions is of first priority within the MEA plan to abate industrial pollution in Egypt as follows:

For the East Delta region, the following plants are targeted as priorities for pollution control actions:

- A textile factory in Kafr Sakr that discharges untreated industrial wastewater in the Abou Yasin drain.
- An olive oil factory in Qunaiat that discharges in the Qunaiat drain.
- An oil and soap factory in El Ibrahimia that discharges in the Akwa drain.
- Egypt Oil & Soap factory in Sendoub that discharges in the Mansoura drain.

For the Middle Delta region, the following plants are of priority consideration for pollution control actions:

- Tanta Textile Company at Mit Hibish that discharges in the Mahalt Rouh drain.
- Tanta Textile Company at Qunaiat that also discharges at Mahalt Rouh drain.

<u>*Comments*</u> Experience showed that effective end-of-the-pipe treatment of industrial wastewater needs large capital investments and considerable annual operational costs. However, if it is preceded with implementation of the low-cost pollution prevention measures, the treatment cost could be reduced by 40-60%. Therefore, we strongly recommend the adoption of policies encouraging Egyptian industries to take pollution prevention approaches.

3. MEA Policy Vision

Early in the 20th century, traditional industries, such as spinning and weaving, sugar, paper, and cement, were established in Egypt, where the raw materials for these fundamental industries exist in abundance.

Starting the second half of the century, with the 1952 Revolution, attention was focused on expansion in heavy and sophisticated industries. Accordingly, fast growing industrial complexes were developed without taking into consideration the adverse impacts that these industries inflict on the environment. Most of these industrial facilities discharge their effluents into the Nile, its branches, canals, and agricultural drains.

An appreciable percentage of wastewater pollution occurs due to lack of proper maintenance procedures, housekeeping, and adherence to standard operational procedures. When these three principles are properly implemented, a noticeable reduction in pollution loads will occur with minimum costs (low-cost measures).

Most of the polluting practices adopted by Egyptian industries were overlooked because the environmental dimension was always absent either at the decision-making, middle management, or the operational levels. And this is where MEA and the Egyptian Environmental Affairs Agency (EEAA) are playing a significant role now.

MEA Policies

MEA and EEAA set a long-term objective to minimize/eliminate the industrial pollution loads received by water bodies. To that effect, MEA has adopted a two-pronged approach towards Egyptian industries. The first one is to educate/train the industrial community on how to adopt and implement measures to control/prevent pollution. The other approach is to enforce the law and expose the major polluters.

It is worth noting here that MEA declared the year 1998 the year of the Nile. Through a well-organized campaign, led by her Excellency the Minister, the major polluting plants, which were dumping raw industrial wastewater into the Nile, were forced to clean up their act and invest about L.E. 100 M to build wastewater treatment facilities.

Until the mid-1990s, pollution prevention, cleaner production, and environmental management systems in general were new concepts to Egyptian industries. Since 1994, EEAA, through several projects sponsored by various donor organizations, has been

introducing Egyptian industries and consultants to these new areas of expertise. These interventions were carried out through a set of projects that achieved various degrees of success.

MEA's aims are as follows:
- Long-term objective: To introduce the environmental dimension in development policies, national planning, and all programs and projects in order to ensure the achievement of sustainable development.
- Short-term objectives: To control sources of pollution and reduce pollution loads, and to protect, preserve, and manage natural resources within the framework of sustainable development.

One of the main guidelines of this policy is "to deepen the concepts of partnership, coordination, and cooperative work, in the field of environment, between various groups of society on the national level". To that effect, MEA is encouraging the implementation of joint initiatives with other ministries, authorities, and organizations. Broadly, these initiatives involve:
- The preservation of water resources by encouraging the reuse of treated wastewater for irrigation; and
- Encouraging recycling, reuse, and conservation.

MEA's vision has been translated into a series of actions in distinct forms:
- Building internal capacities, within EEAA, to strengthen the enforcement actions.
- *Fast-track initiatives: to ensure industrial compliance and Nile protection.*
- *Donor-funded projects: to showcase and implement environmentally sound concepts and practices in order to help the Egyptian industries adjusting to the new realities, and also to build capacities to deal with compliance and enforcement issues.*

MEA Donor-funded Activities

The following is a list of donor funded projects aimed at helping industries reduce their pollution loads and preserve resources (6):

1- *Environmental Pollution Prevention Program (EP3): A USAID-funded project aimed at presenting the concepts and procedures of pollution prevention to Egyptian industries, with focus on the most polluting sectors. 1994-1998.*

The project had three components. The first component was designed to address the Egyptian industries at large, with a focus on Cairo. It comprised a component for general environmental awareness and pollution prevention training. In addition, it also involved implementation of pollution prevention practices in 20 industrial facilities within Greater Cairo. The second component was identical to the first, but it was implemented in Alexandria. The third component was implemented in the 10 of Ramadan. In addition, EP3 was the first project to introduce the Environmental Management Systems to Egyptian industries, in the fall of 1996, with a focus on ISO 14000.

EP3 could not achieve most of its objectives due to basic flaws in its design. However, it did convey a strong message to Egyptian industry and the community of environmental *consultants about the importance of pollution prevention, cleaner production, and environmental management systems.*

2- *Support to Environmental Assessment and Management Project (SEAM): A DFID-funded project aimed at capacity building in the areas of EIA, industrial auditing, and Governorate Environmental Action Plan.*

The project focused on capacity building of the Egyptian consultant community in the field of industrial environmental auditing. It also assisted EEAA and EMUs in several governorates in developing Governorate Environmental Action Plans. During the process of plan development, major environmental issues within the Governorates were identified, realistic solutions were proposed, and action plans for implementing these solutions were developed.

3- *Environmental Protection Fund Project for Industrial Public Enterprise Companies: This is a KFW-funded project aimed at financing investments to improve environmental protection in public sector companies, concentrating on wastewater treatment.*

This project is designed to assist the public sector industries to comply with environmental laws and regulations. Unfortunately, it started before EP3 had a chance to strongly deliver its message. The number of industrial facilities responding to this project is much less than what was predicted during the design phase of the project.

4- *Industrial Pollution Abatement Program (EPAP): This project aims at financing environmental initiatives in industrial projects and providing technical assistance including the preparation of environmental audits and action plans for most polluting industries. Launched in 1997, the project is funded by the World Bank, European Investment Bank, and the Finnish Government.*

This project also focuses on building capacities of the Egyptian environmental consultant community to establish self-monitoring systems for industrial facilities. In addition, it is assisting EEAA, the regional branches of EEAA, and the governorates' environmental units in building capacities in the field of environmental-industrial inspection. This project is among the more successful ones in achieving its objectives.

5- *The "Biological Treatment of a Section of Bahr El Bagr Drain Water before Reaching Lake Manzala" project aims to use the engineered "wetlands" technique in the treatment of a section of the drainage water. The project is funded by GEF and started in 1997.*

<u>Comments</u>

These projects achieved various degrees of success. Lessons learned can be summarized as follows:

- *During the design of a project, special attention should be given to the institutional mechanism by which the various components of the project will be materialized.*

- *Close attention should be given to cultural differences between the donors' nationals and the local staff.*
- *Technology transfer means not only equipment transfer but also the training in management, operation and maintenance.*
- *A big percentage of industrial pollution could be eliminated by simply improving current practices, such as proper maintenance and adherence to standard operational procedures.*
- *Non-technical causes of pollution can have far more impact than technical ones, and they have not been fully addressed yet.*

4. Inter-Ministry Cooperation

In this section, laws, Presidential and Ministerial Decrees that govern the treatment and disposal of liquid wastes are presented; in addition to the ministries, authorities and organizations that are involved in liquid waste management in Egypt. This is followed by a closer look at the roles and responsibilities of MWRI, MEA, and other ministries in industrial water pollution control, and how these roles can be translated into a harmonized action for cleaning industrial pollution.

Laws and Regulations for Water Pollution Control

Potable Water:

- Law 27/1978 regulates public water sources used for drinking and domestic purposes.
- Presidential Decree 27/03 1966 established the Supreme Committee for Water, and provided its mandate, which is concerned with all health matters, setting specifications and standards, and approval of water treatment projects.
- Supreme Committee for Water, Annex IV 1-7-75 established specifications, standards and indications of pollution.

Wastewater:

- Law 93/1962 deals with sewage disposal in public sewers and mandates that samples be taken by the MOHP and analyzed at specific laboratories.
- Ministry of Housing and Utilities Decree 643/1962, implementing Law 93/1962, deals with the standards, specifications and methods of analysis needed to implement Law 93/1962.
- Law 48/1982 concerns the protection of the Nile and all of Egypt's waters from pollution.
- Ministry of Irrigation Decree 8l1983, which implements Law 48/1982, sets the regulations, standards, and specifications for treated wastewater before discharge to surface water, and demands from the facilities that samples be taken and analyzed.

Sea Water:

- Law 72-1968 complements the International Convention for the protection from pollution of the sea by oil, adopted by Egypt through Presidential Decree 421/1963.
- Presidential Decree 1948/1965, as amended by decree 691/1972, established a permanent committee for prevention of pollution of the sea by oil.

Water Quality Monitoring

There are 172 fixed points on the Nile and its branches to monitor sources of pollution. There are 24 parameters for analysis and routine, periodic inspections of all water treatment plants.

Involved Ministries and Agencies

The following ministries and agencies have responsibilities for clean water regulation:

- Ministry of Housing and Public Utilities Agencies:
    - National Organization for Potable Water and Sanitary Drainage (NOPWASD)
    - Greater Cairo Authority for Sanitary Drainage
    - Cairo Sanitary Drainage Authority
    - Greater Cairo Water Authority
    - Alexandria Water Authority
    - Alexandria Sanitary Drainage Authority
    - Beheira Water Company responsible for drinking water and sanitary drainage
- Supreme Committee of Water
- Ministry of Environmental Affairs
- Ministry of Health and Population
- Ministry of Water Resources and Irrigation
- Ministry of Industry
- Ministry of Agriculture and Land Reclamation
- Ministry of Interior
- Ministry of Communications and Marine Transport
- Ministry of Petroleum
- Ministry of Justice
- Ministry of Tourism
- Academy of Scientific Research and Technology
- Sea ports Authorities
- Relevant Governorates
- Suez canal Authority

While many ministries and governmental agencies are involved, to one degree or the other, in monitoring the quality of water in Egypt, the Ministry of Water Resources and Irrigation has the major role, according to Law 48/1982.

Cooperative Responsibilities

Responsibilities of MWRI and MOHP

Law 48/1982 Article 3 states: The Ministry of Health and Population (MOHP) carries out, in its laboratories, periodical analyses of samples taken from the treated wastewater and from industrial facilities that are licensed to discharge into water streams, according to a planned timetable, in addition to any other analysis required by the MWRI.

MOHP departments are responsible for sampling and analyzing, at the licensee's expense. The licensee must deposit funds in advance at the MOHP to cover the cost of sampling, transportation, and analyses. The amount is determined according to the type of waste.

MWRI and the authorized person are notified of the results of the analyses. If the discharged liquid wastes are in violation of the standards and specifications stated in the permit and do not represent an immediate hazard, the owner should take necessary actions to comply within a three-month grace period. Samples will be taken, after the grace period, and analyzed. If subsequent analyses show that no effective action has been taken, MWRI will cancel the facility's permit and prevent it from discharging on the waterway by a legal-administrative procedure.

If the analysis shows that the discharges are in violation of the law and cause an immediate hazard on the water body, the authorized person will be notified to immediately eliminate the causes of hazard. Otherwise, MWRI will suspend the damaging activity at the owner's expense, or cancel the facility's license and prevent it from discharging on the waterway by a legal-administrative procedure.

From the above article, it is clear that:

- MWRI has the leading role in protecting the quality of water in the water bodies.
- MOHP has the supporting role of sampling analyzing, and reporting.

Responsibilities of MEA

The role of MEA (and EEAA) in industrial pollution control is based on Articles 17 and 18 of the Executive Regulations for Law 4/1994 (Prime Ministerial Decree # 338/1995).

Article 17 states: Establishment owners shall, according to the provisions of these Regulations, maintain a register to record the extent of their establishment's impact on the environment as follows: …

Establishment owners or their representative are obliged to notify the EEAA immediately, by registered mail with return receipt requested, of any deviation in the criteria and specifications of emitted or discharged pollutants, and the procedures taken to rectify them.

Article 18 states: The EEAA shall be competent for the follow-up of the registered data to ascertain its conformity with actual fact. It shall also take the necessary samples and conduct the appropriate tests that show the impact of establishment activities on the environment and establishment compliance with criteria set for protecting the environment. Such follow-up shall be undertaken every year. A report on each follow-up shall be files with the competent sector within the EEAA, shall be signed by the officer in charge of follow-up tests, and shall include dates. If any violations are discovered, the EEAA will notify the competent administrative authority, which shall demand from the establishment's owner, by registered mail with return receipt requested, expeditious rectification of such violations according to industry norms. If he fails to accomplish this within 60 days, the Executive Head is entitled, in coordination with the competent administrative authority, to take the following measures:

- To close down the establishment
- To suspend the damaging activity
- To file a lawsuit demanding suitable compensation to remedy the damages resulting from the violation

Establishments shall maintain registers, on a permanent basis, according to the form prescribed in Article 17 of these Executive Regulations. Whenever new data is registered, establishments shall maintain it for a period of ten years effective from the date of signature of the EEAA representative in the register confirming its review".

These two articles
- give EEAA the authority and responsibility to inspect industrial facilities in order to check the credibility of their Environmental Registers;
- give EEAA the authority and responsibility to take samples and analyzes them from the inspected industrial facilities;
- give the Executive Head the authority to coordinate with the competent authority to take necessary measures against the violating industrial facilities.

Potential Coordination Areas between MWRI and MEA

At first glance, the roles and responsibilities of MWRI and MEA (and EEAA), as mandated by law, may seem somewhat contradictory. However, a closer look reveals a comfortable area for coordination in reducing industrial pollution from agricultural drains and providing Egypt with millions of additional cubic meters of useable water. The following is a logical argument that can form the basis for coordination between the two ministries:

- MWRI is the competent authority to protect the quality of water in surface-water bodies.
- MEA (and EEAA) is the competent authority to inspect industrial facilities for violations related to their environmental performance, as recorded in their Environmental Registers.
- The Chairman of EEAA should consult with the competent authority to take action against the violating industrial establishment.

The *scope of coordination* should include all industrial facilities with permits to discharge industrial wastewater to surface water bodies. However, it will be more realistic if the coordination follows a stepwise plan, starting with a specific geographical area, and gradually increase the geographical scope in stages. We recommend here that the first stage should cover the industries discharging to the agricultural drains of the middle Delta and the drains feeding El Salaam canal.

The mechanism of coordination should entail the formation of a joint MEA-MWRI committee to develop an action plan to reduce, and hopefully prevent, industrial wastewater pollution in agricultural drains. Proposed actions include:

- Review the list of industries that are discharging to drains.

- Develop a priority list of these plants.
- Develop a plan to approach these plants to encourage/force them to adopt and implement low-cost pollution prevention measures.
- Develop a follow-up plan with the industrial plants.
- Develop a plan for regular analysis of drainage waters at identified sites, in order to determine improvement, if any.
- Report progress, identify barriers, and recommend solutions.
- Review the process and recommend corrective actions.

Recommendations for Implementation

- Regional branches of EEAA are important executing arms. The Middle Delta Branch, for example, is a newly developed office for integrated management of the environmental affairs in the entire region. It takes a while for the new office to build its needed capacities, and we recommend the involvement of MOHP in environmental laboratory activities.
- The unlicensed industrial facilities that illegally discharge to the drainage system may contribute a sizable portion of industrial pollution. A realistic workable plan should be developed with the pertinent authorities to face this situation.
- It is very important to build a good level of trust, especially at the middle management and operational level, between parties. Every side should be part of the decision-making process, with clear identification of the various roles of the parties.

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POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 34, Appendix 5
Wastewater Effluents Administration and Management

November 2000

Water Policy Program

Report No. 34

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Appendix 5

Wastewater Effluents Administration and Management

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1. Introduction

Advance is not measured by the amount of resources a country has but rather by the best and utmost use of resources to serve national goals. Water is the most precious of all resources as it is the essence of life itself. Hence, preserving water and keeping it clean and pure for all purposes is a national duty.

The Nile River represents more than 95% of the water resources of Egypt. Agriculture is the major activity of water consumption (85%), in addition to other important uses such as drinking, industrial use, power generation, and navigation.

In 1950, the Egyptian population was less than 20 million, and the water resources from the Nile were 48 bcm/year. That means the share per capita was around 2,400 m^3 per year. During the second half of the century, the population reached 65 million, while the available Nile water rose only to 55.5 bcm/year, according to the 1959 Nile Water Agreement, equaling a share per capita of 850 m^3 per year.

The current challenge is to foster sustainable development through agricultural, industrial, and social projects and to establish new communities with the limited water resources. Consequently, all the available water resources must be put to their the optimum use. Agricultural drainage water, treated sewage, and industrial wastewater should be re-used. Groundwater should be preserved pure and non-polluted, and its use should be developed.

2. History of Water and Wastewater Development in Egypt

Before the construction of the High Dam, the annual floods, with their huge quantity and tremendous speed, swept all kinds of pollution into the Nile and through it into the sea. But the High Dam has changed the hydraulic system of the Nile; the river's flow is now controlled according to water needs.

In the meantime, there has been rapid agricultural, industrial and housing development. Furthermore, the basin irrigation system has been changed to perennial irrigation, and there is much discharge from the agricultural drains along the Nile Valley. All these factors have caused the pollution of the Nile.

Before 1950, services in the fields of pure drinking water and sewage were insufficient. Most rural and urban areas were deprived of such services. After the revolution of 1952, a comprehensive development phase began. Its most important characteristics were:

- Major industrial development and the establishment of many factories.
- Agricultural development and horizontal expansion into the deserts near the Delta and the Valley.
- Transfer of about one million feddans from the basin irrigation system into the perennial irrigation system.
- Social services improved through supplying the villages and cities with drinking water, electricity, roads, etc.

Increasing demand on water was the result of this development. With limited resources, it was necessary to reconsider the use of the waters of agricultural drainage, treated industrial and sewage drainage, and groundwater. However this development represented negative impacts on the environment, including the following:

- The treatment units of industrial drainage water have not been sufficient, and waste is thrown into the Nile without being treated.
- The huge expansion in use of agricultural fertilizers and pesticides negatively affects the quality of agricultural drainage.
- Provision of drinking water to villages and cities has expanded without a concomitant expansion in sewage treatment. Thus, household wastewater is often dumped into freshwater courses and agricultural drains.

The issue of industrial and sewage drainage is a complex one. Climatic and geographical conditions have led to the concentration of most of the population near the water resources. Yet most villages and cities lack industrial and sewage drainage networks, which has led to the contamination of the watercourses which spread like veins through the Delta and the Valley. The random housing expansion and the intermingling of the watercourses within these housing blocks has led to the discharge of untreated liquid wastes into the waterways.

As a result of these changed conditions, many new laws were made concerning public cleaning and the discharge of liquid wastes (e.g., law no 93/1962). Actual practice of the laws has revealed deficiencies in some articles and mal-distribution of responsibilities and qualifications among the bodies and authorities, which caused a loss of commitment. Consequently, it was necessary to adopt a strict policy to regulate the use of wastewater. Therefore, Law 48/1982 was issued concerning the protection of the Nile and its waterways from pollution.

Law 48 made some clear rules concerning use of the watercourses. Article II warns against discharging waste into watercourses and gives MWRI the authority to execute the law and issue discharge licenses along watercourses according to the standards set by the Ministry of Health and Population (MOHP). According to Law 48, MOHP is responsible for monitoring the water quality and taking samples for analysis. However, MWRI has not managed to fully apply law 48 to stop pollution. This problem is a major one; it cannot be solved merely by one law, as it is the result of economic, social and environmental elements, including the following:

- Treating industrial drainage water to within the law's standards requires construction of water treatment plants. Such plants require great investments without any profitable return, which is why the establishment of water treatment units is very slow. Strict application of the law would lead to shutting down these factories, which would have harmful social and economic effects.

- Sewage treatment in Egypt is the responsibility of the Ministry of Housing and its specialized agencies. The Ministry will use all available resources (capital, technical and administrative elements) to establish the networks and stations for sewage water treatment nationwide. Still, the pace of this operation is very slow and its implementation is far behind the target ratio, covering only 10% in rural areas and 50% in major cities. Moreover, the treatment standards fall short of law 48 standards. Lack of communication and coordination between the Ministry of Housing and MWRI means that the implemented units do not serve MWRI's priority water reuse areas. And there are deficiencies in the technical staff that mange and maintain these stations.

- Egyptian citizens are some of the main polluters, yet they are the ones suffering from this problem. Water pollution is a very dangerous problem that threatens present and future generations. Awareness programs and alternative wastewater locations or systems are crucial.

3. Status of Management and Administration

Institutional Framework

The Ministry of Water Resources and Irrigation (MWRI) is the primary Egyptian governmental agency charged with the management of water resources. The MWRI is responsible for the proper management, allocation, and distribution of all water resources in Egypt, with respect to both quality and quantity, whether it is surface or groundwater.

There are two main units within the MWRI: the Irrigation Department and the Drainage Authority. Together, these administrative units are responsible for the operation, maintenance, rehabilitation and project implementation of the irrigation and drainage systems. The irrigation directorates are under the supervision of the Irrigation Department and the Drainage Directorates are under the supervision of the Drainage Authority. The irrigation and drainage directorates are divided into districts for irrigation and for drainage. The district engineer is normally responsible for the operation and maintenance of 20,000–50,000 feddans. The district engineer is the only representative of the MWRI with whom water users come into direct contact.

Before the establishment of the Drainage Authority, there was one system for irrigation. Drainage was managed by the Irrigation Department, which was responsible for all operation, maintenance and rehabilitation processes of the irrigation / drainage system through its directorates and districts. Upon the establishment of the National Drainage Authority for Drainage Projects, it was found that tile drainage required special maintenance. Hence, the tile drainage maintenance directorates were developed. Afterwards, open drains were transferred to the Drainage Authority in order to control the total drainage network.

At the national level, seven other ministries are involved in water resources management. They are the Ministries of Agriculture and Land Reclamation, Transport, Tourism, Housing and New Communities, Health and Population, Power, and Industry. In addition, there are several inter-ministerial committees with the aim of coordinating between the involved parties and enhancing horizontal communication and information exchange.

Legal Framework

The legal framework for water resources management is established in a number of laws and ministerial decrees, of which the most important are:

- Law 93/1962 concerning drainage of liquid wastes, implemented by ministerial decree 649/1962 (Ministry of Housing and New Communities). This decree regulates the discharge of wastewater into the sewer system for use in irrigation and in case of application to the land. The part of decree 649 that regulated drainage to watercourses was replaced by law 48/1982.

- Law 48/1982 regarding the protection of the Nile and waterways from pollution, is implemented by MWRI decree 8/1983. This law defines different types of waterways and regulates the discharging of liquid waste into the waterways. MWRI is responsible for licensing wastewater discharge, while the Ministry of Health is responsible for monitoring water quality. Decree 8/1983 specifies standards for disposal of wastewater under different conditions and also for receiving water. However, the enforcement and application of this law has encountered certain constraints, and the GOE is exerting utmost efforts for the treatment of the sewage and industrial wastes which are the main pollutants of the waterways.

- Law 12/1984 on irrigation and drainage regulates the use of water, including groundwater. It also regulates the operation of canals, drains and water lifting devices. It controls water rights, sets priorities between users and beneficial and harmful uses of water, and controls financial aspects and penalties.

- Law 4/1994 on environmental protection describes the tasks of the Egyptian Environmental Affairs Agency (EEAA), provides general rules for the protection of the environment, and controls air pollution and the use and protection of the marine environment.

Other laws and decrees are more specific, such as law 27/1978 regulating public water resources used for drinking and domestic use. Ministry of Health decrees 301/1995 and 108/1995 define the specifications for the water inlets to drinking water treatment plants, their protection from pollutants, the norms and specifications of treated drinking water and its use.

Ministerial decree 380/1982 of the Ministry of Industry obliges new industries to install the necessary equipment to prevent pollution in the technical specifications of the new projects.

The DRI is responsible for the drainage monitoring network. The network consists of more than 100 sites for measuring flow and water salinity in main drains and branch drains in the Nile Delta and Fayoum, where they have been established and became fully operational since 1984. The measuring and the strategy sites are selected at drainage pumping stations and along the open drains, respectively. The sites are provided with automatic recorders. Water samples are collected monthly at these sites for laboratory analysis of the concentration of main ions, total dissolved salts, and sodium absorption ratios.

Egypt's Nile Valley and Delta irrigation system is unique in the world in that it is one total system providing water for all purposes in Egypt. The irrigation and drainage waterways are inter-related systems. For example, drainage water is reused when it is mixed with the irrigation canal system through the return flow from the over irrigation canal systems to the drainage systems by the tail escape. These two systems are located next to each other because of their " give and take" relationship.

Maintaining water quality requires the integration of irrigation and drainage departments. Separate management of irrigation and drainage systems has resulted in several problems:

- Organizationally, there is both an irrigation district engineer and drainage district engineer who are working in different departments. These two must communicate at least twice a week.
- It is very difficult to manage inter-related systems with three separate departments, i.e., the Irrigation Department, Drainage Authority and Mechanical Department. For example, in the northern Delta, where rainfall is often unpredictable, most of the drainage water goes to the sea and lakes via gravity and pumping. The excess water from rainy days affects the drains when land irrigation stops but flow from the Aswan Dam was released 10-15 days before. The used large canal flow from rainy days goes to drains through canal tail escapes, as happened in 1992.
- The major question is: how do end-users or stakeholders get help when they have problems of intermixing between irrigation and drainage?

For better use and stronger management of the water resources in Egypt, integration of irrigation and drainage at every management and administrative level is a must.

4. Wastewater Monitoring and Potential Reuse

Drainage water is loaded with different sorts of pollutants from agricultural, industrial or domestic sources. Salts, nutrients and pesticides run off of irrigated fields and are carried by drainage water. Untreated industrial effluents discharged into the drains contain heavy metals and organic materials. Similarly, untreated domestic wastewater containing organic materials, bacteria and pathogens is disposed into drains.

Monitoring

The MWRI is entrusted with monitoring the sources of pollution and enforcing the water quality protection laws. Monitoring and detecting violations is the first step in water quality management improvement. Through a Dutch-supported project concerning the integration of water quality monitoring activities in Egypt, a survey was conducted to examine the efforts exerted on water quality activities. The results were instructive: twenty-five agencies under seven ministries are involved and responsible in some way or another. However, unfortunately, most of these monitoring activities are not conducted on a regular basis. They represent studies of specific problems in some limited locations, but not a systematic or comprehensive approach.

A national water quality monitoring program is needed, as the status of water quality nationally is sketchy. This is due to the fragmentation of monitoring activities carried out by different entities within and outside MWRI, gaps in geographical coverage (no data is collected routinely from the drainage system in Upper Egypt or the canal system in general), and the fact that most of the data collected is for conventional pollutants (salinity), not toxic pollutants.

Due to the length of the drainage network and the huge varieties of pollutants, the DRI started a project in 1996 with five reconnaissance surveys at almost 240 locations along the main drains and branches (almost 18,000 km) in the Delta and Fayoum. At each location, water samples are collected for laboratory analysis. The concentrations of 30 parameters have been determined. The available data on drainage water pollution is to be regularly distributed to the planning and irrigation sectors of the MWRI. The information is also given to the EEAA, as it is the national institute responsible for the Environment in Egypt.

Although these surveys analyzed the salt concentration and the ratio of the other pollutants and their impact on the soil in the case of use in irrigation, the results cannot be classified as comprehensive data on water quality control. Moreover, the DRI concentrates on the drain networks in the Delta and Fayoum, ignoring that of the Upper Egypt and ignoring irrigation networks as well, although the receive huge quantities of pollutants.

Implementing a water quality management system requires that the water quality monitoring network include all the irrigation and drainage networks in Egypt. It should map the sources of contamination, recognize the quality and quantity of these pollutants, and analyze them to determine their components. A comprehensive water quality database should be made, as the human, technical, and institutional potentials of the MWRI in this field are very weak

Wastewater Reuse

The final step of the DRI's ongoing programme is to integrate the drainage water quality and quantity monitoring programmes together. The reuse of drainage water in the Nile Delta and Fayoum has been adopted as an official policy in the late seventies. This policy calls for recycling agricultural drainage water by pumping it from main and branch drains and mixing it with fresh water in main and branch canals.

The criteria for mixing is based on the suitability of the blend for irrigation of all crops. The quantity and quality of the drainage water at the mixing point, therefore, determines the mixing ratio. The DRI has been charged with developing the necessary tools and guidelines for implementing the drainage water reuse policy on a sustainable and sound basis. Careful management of drainage water requires answers to many questions, such as:

- How much drainage is available at a specific site along a drain at all times?
- What is its salt concentration?
- How do these characteristics change with time?
- Is it possible to predict future changes in drainage water quality and quantity?
- Is it possible to predict the effect of irrigation with drainage water on soils and crop yield?
- What is the most convenient way to supply and apply drainage water for irrigation?

An integrated water management simulation model has been developed by the DRI, with technical assistance from the Netherlands. The Simulation of Water Management with the

Arab Republic of Egypt (SEWARE) model is calibrated, tested and validated for any given water management and cropping pattern scenario. The SEWARE model can determine the long-term impacts on soil salinity and crop yield. It is therefore used to analyze water management and the water and salt balances of a catchment or a region.

5. Constraints to Water Pollution Control

Institutional Constraints

The Irrigation Department and the Drainage Authority are the executive bodies responsible for all water resource management and maintenance in Egypt, yet they both have limited human or technical potential, and do not have the means or the laboratories to determine or control water quality. They have nothing but law 12/1984 and law 48/1982, which are hardly applied. These authorities are in need of:

- *institutional support*
- *well-trained staff of water quality specialists*
- *well-equipped laboratories*
- *proper measurement and grid tools*
- the financial resources necessary to operate the system, practically and scientifically, to preserve water quality.

In general, the institutions and ministries involved in water quality monitoring and control suffer from the following constraints:

- Lack of coordination, communication and cooperation between the parties concerned with water quality at the central and local levels.
- The human element will remain the most important factor in managing water quality. However, human resource development in the field of water quality is insufficient. Development of trained technical staff should be one of the main concerns of ministries and institutions.
- The main problem regarding water quality and pollution control is the absence of an integrated, coordinated approach that is policy-driven and takes into account agreed priorities. There is no joint strategy or action plan that coordinates the different tasks of the involved ministries and institutions.

Capacity Building and Institutional Development

Capacity building is the foremost strategic element in the sustainable development of the water sector. MWRI experience shows that institutional weakness is a major cause of ineffective and unsustainable attention to building institutional capacity at all levels. The critical new institutional challenges should be directed to developing policies, rules, organizations and management skills to improve the quality of decision-making, sector efficiency in the planning and implementation of water sector programmes, and water quality control.

Limited Awareness of Water Quality Issues

The high prevalence of illiteracy and lack of awareness of water consumers both represent barriers to water quality control. Public awareness campaigns and education programmes could have a potential role in changing human behavior concerning water quality and use. Public awareness tools should always accompany other programmes to increase efficiency.

Lack of Funds for Water Quality Control

Egypt suffers from the lack of funds necessary to establish water quality development programmes and projects. Major emphasis should therefore be given to developing a new source of funds. Among these approaches are the measures that seek to mobilize local funds, in particular under the "user pays" and "polluter pays" principals.

Building the necessary institutional capacity and generating support and participation by stakeholders in assuming financial responsibility, although critically important, will be difficult and time consuming given the acute economic difficulties facing Egypt. This will in turn require continued heavy dependence on foreign sources for assistance.

Constraints Facing the MWRI in the Water Pollution Problem

Despite the MWRI's successes in the management of water resources and fulfilling the water usage requirements, pollution of all the waterways of the Nile, the irrigation and drainage canals, and even the groundwater aquifers remains a grave problem. There are two main factors contributing to this problem: geographical and economic.

The geographical factor

More than 95% of the population and its activities (agriculture, industry, etc.) accumulate around the Nile Valley and the Delta, which represents only 4% of the total area of Egypt. Consequently, more than 95% of Egyptian water resources are consumed in this narrow, crowded area of Egypt's land. Furthermore, there is random intermingling of population centers with industrial establishments and sewer courses. Due to the shortage in industrial and sewage treatment stations, and the deficiency of their performance, the only way to get rid of liquid waste, and sometimes solid waste, is throwing them into the Nile and the other watercourses.

The economic factor

The sole solution, then, is the treatment of liquid waste before it is thrown into the watercourses. This treatment should comply with law 48 through establishing liquid waste treatment stations for sewage and industrial wastes, in addition to controlling the use of fertilizers and pesticides required for agriculture. Establishing these stations, preparing plans and timetables, and making implementation priorities in order to benefit from these stations surely would require huge investments.

This recommendation seems logical and in fact, all of these steps have been taken before. Plans and timetables were prepared to protect the Nile River and the watercourses from the industrial drainage wastes. The sources of pollution and its quantity were determined. The Public Authority for Manufacturing, in collaboration with EEAA, made an industrial environmental map that served as a comprehensive survey of the industrial environmental *condition, the pollution loads resulting from liquid wastes, and the sites and quantity of drainage. The Public Authority for Manufacturing also made a list of the heavy metals found in liquid industrial wastes.*

Based on the data of the aforementioned map, a national plan for environmental protection was prepared in 1992 by the EEAA with the cooperation of the group of the donating countries and the World Bank. The factories discharging into the Nile, the canals and the drains were identified, and the implementing priorities were set. The contractor companies were to be financed through the grants and loans of this proposition. However, none of these promises have been fulfilled.

Considering that most of the companies have transferred from the public sector into the private sector and are on their way towards total privatization, not to mention that they suffer from financial crises, most of the industrial companies consider the treatment projects as non- productive. For that reason, they do not give them any priority in the budget. Realizing that the ultimate penalty of shutting down the plant would put thousands of employees out of work, affecting the national economy, the companies do not take the penalties seriously.

There must be a practical, applicable way to continuing production while minimizing pollution. Providing the necessary cash and the real investments is indispensable, in addition to putting an obligatory fixed timetable for the industrial drainage water treatment. The proposed solutions include:

- *Supporting the companies financially*
- *Supporting the companies technically*
- *Linking the industrial drainage companies with those of the sewage networks.*
- *Applying the law after modifying the standards of water specifications.*

The same applies to sewage, as the Ministry of Housing and new Communities, through its specialized authorities is making the programmes and the five-year plan for implementing the sewage water treatment networks and stations in the rural and urban areas nationwide. The ministry has a comprehensive plan, still the finances allocated for these operations is inadequate. The shortage of money and allocations, then, is the main cause of the escalating problem and the first justification for throwing untreated liquid waste into the watercourses. It is clear that it is basically an economic problem.

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POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Report No. 34, Appendix 6
Priorities for Improving Drainage Water Quality in the Delta

November 2000

Water Policy Program
International Resources Group Winrock International Nile Consultants

Task Order No. 807
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Report No. 34

POLICIES AND PROCEDURES FOR IMPROVED URBAN WASTEWATER DISCHARGE AND REUSE

Appendix 6

Priorities for Improving Drainage Water Quality in the Delta

Prepared By

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LIST OF ACRONYMNS

BCM	Billion Cubic Meters
DSS	Decision Support System
EPADP	Egyptian Public Authority for Drainage Projects
GOE	Government of Egypt
EEAA	Egyptian Environmental Affairs Agency
EPIQ	Environmental Policy and Institutional Strengthening IQC
O&M	Operations and Maintenance
MALR	Ministry of Agriculture and Land Reclamation
MCM	Million Cubic Meters
MOHP	Ministry of Health and Population
MWRI	Ministry of Water Resources and Irrigation
NA	Not Available
NOPWASD	National Organization for Potable Water and Sanitary Drainage
NWRP	National Water Resources Plan
WWTP	Wastewater Treatment Plant

1. Introduction

The EPIQ Water Policy Reform Program is charged with advising and providing technical assistance to the Ministry of Water Resources and Irrigation (MWRI) of the Government of Egypt (GOE) with respect to improved policy assessment and planning, improved irrigation system management and improved private sector participation in policy reform. The EPIQ program is part of the USAID Agricultural Policy Reform Program (APRP). The program is currently implementing work plan activities related to Tranche IV policy benchmarks.

APRP Tranche IV Benchmark B.2 requires that GOE (MWRI) adopt policies for improved management of discharge and reuse of urban wastewater in agricultural drains. The large volume of urban sewage discharge pollutes agricultural drainage and increasingly threatens the sustainability of drainage reuse in the Delta. Serious policy actions to combat the pollution and prevent further degradation of the region's drainage water are urgently needed.

This benchmark will identify the policies and administrative procedures to facilitate the establishment of a sustainable management system for receiving and reusing wastewater effluents in agricultural drains. An important feature of the benchmark is the involvement of other related ministries and agencies in policy development. Participation, cooperation and consistent policy vision of all parties, both inside and outside MWRI, will be the core of benchmark implementation.

The benchmark will extend over a two-year period. The first year, ending December 31, 2000, will involve the development of an urban sewage discharge policy and administrative procedures. The second year, ending December 31, 2001 will be used to test and adjust the policy and procedures in selected governorates.

This report will introduce a list of areas and agricultural drains within the Nile Delta that should receive high priority in terms of pollution mitigation from the MWRI's point of view. Identifying priority areas is important as the budget needed to treat wastewater all over the country is large and not all measures can be implemented at once. Additionally, interests of different ministries may differ based on their mandate. The criteria used to identify these drains will be discussed and will be in harmony with other MWRI efforts, described in the next sections, to set out MWRI water quality priorities and strategies.

2. MWRI Efforts on Water Quality Priorities and Strategies

Several groups are currently working or have recently completed their efforts to set out water quality priorities and strategies within MWRI. This section will briefly describe the scope of work and conclusions of these groups.

2.1 Task Force on Water Quality Priorities and Strategies

A task force was appointed by the Minister of Water Resources and Irrigation in October 1999 to draft the water quality priorities and strategies of the Ministry. The task force was supported by the Dutch-Funded Advisory Panel Project on Water Management and Drainage. The work was completed and submitted to the Annual Panel meeting held in The Hague, March 2000.

The task force identified health as the ultimate priority for all agencies working in the water sector. This approach was applied to the River Nile, irrigation and drainage systems and groundwater in the Nile Delta and the Valley. The report identifies priority areas where high pollution exists, related to the larger urban centers of the country.

The River Nile: The report concluded that the main river is not subject to high pollution levels that create health risks, expect for some locations where the presence of Coli Bacteria indicates unsafe levels of pollution for direct use in irrigation and fisheries. Lake Nasser currently shows no health risk at all. Nevertheless, it is important to protect this strategic water supply.

The Drainage System: The high priority areas within the Eastern Delta are greater Cairo and the surrounding urban conglomerates and greater Mansoura. In the Middle Delta, the area around Tanta, Mansoura, Mahalla and Samanoud were selected. The area surrounding greater Alexandria and the area served by Edku Pump Station were chosen for the Western Delta. Areas that are officially and unofficially using or intending to use drainage water for irrigation were also considered of high priority.

Groundwater: Regarding groundwater, the overall priority of health can be translated into one specific objective: water standards should be met for the intended use, which in many cases is drinking. The selection of priority areas for groundwater protection was based on vulnerability of the aquifer, potentially polluting activities, and current levels of pollution. Additionally, the report briefly discusses the status of groundwater pollution in new industrial cities and the alarming situation with industrial wastewater injection in the groundwater aquifer.

2.2 National Water Resources Plan Project (NWRP)

The NWRP is utilizing planning tools and the decision support system (DSS), which will enable quantitative analysis and the development of strategies of water quality and pollution control. The basic strategy for this project is to involve stakeholders at all levels. The NWRP main planning approach includes the following:

- Identifying the different actors involved in water quality activities for planning, monitoring and regulation activities.
- Conducting a national survey to determine the existing sources of pollution in all governorates, particularly those related to domestic and industrial wastewater.
- Assessing the main problems and potential solutions and long-term strategies for pollution mitigation.
- Developing the DSS and other associated planning tools, which can be used to support the assessment of various strategies of water quality management and planning.

The NWRP is of a long-term nature and will make use of short-term priority actions designed by the previously mentioned task force and other groups as well. However, NWRP intends to investigate the criteria used to set up these priorities in a more quantitative way, involving all stakeholders and considering other institutional and legal constraints.

2.3 Inter-Ministerial Committee for Nile Protection and Pollution Control

An inter-ministerial committee was formed early this year (2000) to assess the current situation and decide upon needed measures to protect the Nile and control pollution of surface and subsurface water. The committee comprised representatives of all ministries concerned with water quality including MWRI, MALR, MOE, etc. Within each ministry a task force was formed to identify its own set of priorities for protection and pollution control and report back to the committee to form the national work plan.

The task force within MWRI included representatives from the Irrigation Sector, the Egyptian Public Authority for Drainage Projects (EPADP), the Nile Protection Sector, and Nile and Drainage Research Institutes. The report produced by the task force includes a quick assessment of the current status of water resources in the country, in terms of water quality, monitoring activities and correcting violations, and a list of priorities for industrial water treatment and wastewater treatment plants. The highest priority was protecting the River Nile and its branches and controlling pollution on drains currently being reused or soon to be reused for the horizontal expansion project.

3. Criteria for Prioritization

3.1 Criteria for Prioritizing Water Quality Issues

The following criteria are used for prioritizing general water quality issues.

A) Health Protection

The first objective will be to protect the health of people who come into contact with water through various water-related activities. Drinking water is usually supplied from the Nile directly or through canals that use a mixture of fresh (Nile) and drainage water. Groundwater is also widely used for drinking water, without treatment. Under this criterion, Nile Delta drains which negatively affect the drinking water supply will be identified. Density of population around the drain will also be considered. Reducing the pollution load in drains identified will result in the following positive impacts:

- Protection of drinking water (Nile, canal, groundwater) from contamination
- Reduction in the pollution risk for densely-populated areas

B) Sustainable Drainage Irrigation Reuse

The aim under this criterion is to improve the quality of the drainage water to comply with law 48/1982. This will help sustain the operation of functioning drainage water reuse pump stations and stations that are stalled due to high pollution. Satisfying this objective will also ensure the availability of drainage water in terms of quantity and quality needed for the national horizontal expansion plan. The projects currently using or intending to use drainage water irrigation will be sorted according to the amount of drainage water use, degree of pollution, construction stage of reuse pump station and investments needed to rectify the situation. The list of projects will include the following:

- Future projects that depend on drainage water as a main source for irrigation water
- Irrigation projects that finished infrastructure construction and were stopped due to contamination of the drainage water used for mixing with fresh water.

C) Protection of Lakes and Mediterranean Sea

Under this criterion, drains polluting northern lakes will be identified and prioritized according to pollution load, with the goal of protecting the lakes for fisheries and recreation activities

D) Political Factors in Budget Allocation

In establishing the list of priorities, the budget for wastewater treatment facility development, the acceptance and agreement of governorates, and political considerations may overwrite technical and other considerations in the final decision-making.

The prioritization work under criteria C and D is beyond the scope of this report, and will be covered by the reports of the Egyptian Environment Affairs Agency (EEAA) and the National Organization of Potable Water and Sanitary Drainage (NOPWASD) representatives.

3.2 Criteria for Prioritizing Wastewater Treatment Plants (WWTPs)

At the level of each area/drain/project, a list of wastewater treatment plants proposed for construction will be identified in cooperation with NOPWASD. Prioritization of WWTP construction will be based on:

- Quantity of plant effluent dumped in the drain. Hence, large cities like Cairo, Giza, Tanta, Mansoura, etc., will come first.
- Distance of the dumping location from the reuse mixing pump station will also be an important factor, as effluents from treatment plants close to the mixing location will not be adequately exposed to the natural purification process.

This report lists all areas where water quality is of concern under criteria A and B within the Nile Delta only. Details of the WWTP required for each area are illustrated, including capacity, drain receiving wastewater, distance to mixing locations, etc. This information was based on NOPWASD and EPADP data. The recommendations presented for each case are comprehensive in a way that includes not only WWTP suggestions but also some engineering solutions to reduce the pollution load from the WWTPs to the water system. An overall budget for the list of WWTP construction was prepared and presented. It should be noted that the budget estimation was considered only to rectify the drains falling under criteria A and B and did not consider measures needed to protect groundwater, lake Nasser and other water resources outside the Nile Delta (area of the benchmark).

4. High Priority Areas

Table 1 presents a list of the areas satisfying the first two criteria (A and B) and considered highest priority from the MWRI point of view. The table includes 11 main areas in the Nile Delta that need immediate attention to improve the water quality within the current and next five-year work plan. For each area, drains subject to pollution are listed. The table also shows the use (irrigation/drinking) of water after the mixing with drainage water.

Drainage water mixing quantities and number and discharges of treatment plants are also shown for each drain.

Pollution abatement in each of the areas listed in Table 1 is essential to protect the health of people within these areas. Additionally, the list comprises the majority of drainage water reuse projects that are important for horizontal expansion and development of the country. The estimated drainage water irrigation from the listed projects and negatively affected by pollution is approximately 6.5 billion cubic meters (bcm) per year. It should also be noted that the total wastewater from the listed projects is up to 2 bcm/year, which when adequately treated, could contribute to the horizontal expansion projects.

All drains listed in the table suffer from pollution problems due to agriculture, domestic use, and industrial activities and are in turn affecting the quality of water in the canal after mixing and of the groundwater in the areas they pass through. The water from some of these canals is not limited to irrigation, but is also used for drinking purposes (Meet Yazeed, Al Ismailia). In general, all listed projects are either completed or operational, and the current pollution levels suggest that immediate budget allocations for all them is of extreme importance, as they all touch the health of the people and affect the economic development of the country.

4.1 El Salam Canal

Drainage water supplied to Salam canal is estimated to be 2 bcm/year. This quantity is harvested from Bahr Hadous, Lower and Upper Serw together, if needed, and Farasqour drains. This drainage water will be mixed with another 2 bcm/year freshwater drawn from Damietta Branch to reach a total discharge of 4 bcm in order to supply irrigation water to 200,000 feddan in the western Suez canal region and 440,000 feddan in the East, north of Sinai Governorate. Since the catchment area of Bahr Hadous, Upper and Lower Serw, and Faraskour drains are located in highly populated area, all drain systems within the region are susceptible to pollution from legal and illegal dumping of domestic and industrial wastewater. The current proposed mixing ratio of 1:1 between drainage and freshwater might be enough to reduce the pollution to acceptable levels. Additionally, El Salam canal is delivering irrigation water to new land in the Sinai which is free from pollution.

For these reasons, a large program of wastewater treatment plants was approved by NOPWASD covering major urban communities within the basin or catchment area of this drain system. The total number of planned WWTPs in the area is 47, out of which 21 are already constructed yet not operating, and 26 are proposed. The only operating treatment plant is the one for Mansoura City, which has a capacity of 135,000 m^3/day.

4.2 Gharbia Drain

Gharbia drain has a catchment area estimated at 700,000 feddan and covering a heavily populated area in Gharbia and Kafr El-Sheikh Governorates. Gharbia drain has two mixing pump stations downstream from El Segaeia. The first is El-Hamoul, which has a discharge of 1.5 million cubic meters (mcm) per day, reaching 1.8 mcm/day in summer to supply Bahr Terra canal. The second is Botteta mixing pump station, which supplies Rowaina canal with 600,000 m^3/day. Botteta mixing pump station, at present, is not operational due to the pollution coming from the wastewater effluent of the sugar beet factory.

The current quantity of reuse drainage water from Gharbia drain is estimate to be about 1 bcm/year, which is a considerable amount of water compared to total reuse in Egypt. This is in addition to the large quantity of unofficial drainage use which put the Gharbia drain in the highest priority list.

4.3 El Wady and Mahsama Drains

El Wady and Mahsama drains, which run parallel to Ismailia canal, were planned to supply Ismailia canal with 232 mcm/year through Mahsama mixing pump station. This additional water was included in the MWRI policy to cover the shortage of water in Ismailia canal for supplying both Port Said and Suez freshwater canals with enough water for irrigation and drinking.

El Wady drain and its extension Mahsama drain receive pollutants from the legal and illegal dumping of wastewater from both urban and rural communities. The main source of pollution for the two drains is the wastewater of Ismailia city (90,000 m^3/day) and El Tall El-Kabeer (10,000 m^3/day). The El Tall El Kabeer treatment plant is not operational yet; however, most of the wastewater from this area and from the El Abbassa community is dumped illegally into the drain.

Due to high pollution levels, both El Mahsama and El Wady mixing pump stations have been closed, as this reach supplies the irrigation and drinking water to Port Said, Ismailia and Suez cities and all communities along the three canals (Ismailia, Port Said, and Suez freshwater canals).

4.4 Behera Governorate Drains

Drains of Behera Governorate in the Western Delta are included in the MWRI policy for reusing drainage water. At least 1 bcm/year is being considered for supplying Nobariea canal with drainage water, to cover the high demand for irrigation water for the horizontal expansion of land reclamation. There are another three projects for reuse by mixing with freshwater at Mahmoudia canal, and at both Khandak El-Sharky and Khandak El-Gharby canals.

El Omoun Drain

For supplying Nobariea canal with drainage water from Shereshra drain (El-Omoum drainage Water Reuse Project), three mixing pump stations were constructed. El-Shereshra drain collects drainage water from the extension of El-Omoum main drain and from different branch drains, listed below with their corresponding lengths:

- Al Zarazeir drain: 22.8 km
- Sedy Easa drain: 19 km
- Hosh Easa drain: 6.6 km
- Hara drain: 10.7 km
- El Gharby Gabaris drain: 22.7 km
- Al Resemat drain: 3. km
- Al-Gaiar drain: 4.8 km
- Sedy Azab drain: 12.9 km
- Mehalet Keil drain: 13.25 km

- Al-Zeiny drain: 13.2 km
- Al-Helbawy drain: 4 km
- El-Omoum drain extension drains at Abu Hommos drainage pump station.
- North Gannabiet El-Omoum drain: 13 km
- Nobaria drain: 16.2 km

The drainage water system is directed to the three mixing drainage pump stations supplying Nobariea canal by barrage on Omoum drain. The goal is to raise water levels, together with Abu Hommous drainage pump station and Troga drainage pump station, in order to supply the three mixing pump stations with enough for pumping at least 1.0 billion m^3/year to Nobariea canal. However, due to pollution from treated and untreated domestic wastewater, together with the industrial wastes dumped in Omoum main drain, Omoum extension drain, Shereshra main drain and all its branches, the operation of the three constructed mixing pump stations was banned. The mixing of drainage water with wastewater, even treated, will be rejected with the current three drinking water treatment plants located on Nobariea canal downstream from the mixing location.

Edko Drain

Edko drain in Behera Governorate supplies El Mahmoudia canal with water in order to cover the need for irrigation along the canal and for drinking water for Alexandria City. Like all drains in the Delta, Edko drain catchment area covers a highly-populated governorate in which the quality of water in the drain system (main drain and its branches) is getting worse due to legal and illegal dumping of domestic wastewater.

NOPWASD has made plans for six sanitary drainage treatment plants. Three of them are located upstream from the mixing pump station feeding Mahmoudia canal by supplementary drainage water. The mixing pump station supplies Mahmoudia canal with 200 mcm/year and is located at km 38.8 on the main Edko drain.

The first WWTP is the Damanhour plant (Menshiet El-Horreia), which dumps 20,000 m^3 effluent per day in El Hessa drain. The second is Shobrakheet WWTP, with a capacity of 9,000 m^3/day dumped into Shobrakheet drain at km 17.63, upstream from Shobrakeet drainage pump station. The third is El-Rahmania sanitary drainage treatment plant with a capacity of 10,000 m^3/day. The plant is located on Rahmania extension drain.

4.5 Qlabsho Reuse Project

The Qlabsho Project is included in MWRI policy for drainage reuse. Over 1 bcm/year is planned to be used from the No. 1 Upper and Lower drain and for the No. 2 drain. The drainage water will be mixed with canal freshwater to cover irrigation needs for horizontal expansion in the northern Middle Delta. The drainage water is pumped upstream Gamasa weir to Zaian and 15th May branch canals. NOPWASD included seven treatment plants in its plans, of which three are on Lower No. 1 drain basin, three are on Upper No. 1 drain basin, and one is on No. 2 drain.

4.6 El Mouheet Drain

Elmouheet drain in Giza is considered one of the most polluted main drains, coming second only to Bahr El Bagar drain in the Eastern Delta. The problem of Elmouheet drain differs from Bahr El Bagar as it dumps its water into the Nile (Rossetta Branch) while Bahr El Bagar empties into Lake Manzala. The total length of the drain is 70.2 km from the beginning to Rahawy pump station. The main drain starts at El Badrasheen and ends at Mansouria. It receives water from six intermediates on the right side dumping its water in Gannabiete Elmouheet drain El Youmna. Gannabiete Elmouheet El Youmna has 11 intermediates coming from the right side and one from the left. It also receives drainage water from Gannabiete Elmouheet drain El Yousra, with its one intermediate on the left side. The whole system dumps into the Nile through Rawahy Pump Station on the Rossetta Branch. This pump is not working now since the water is flowing to the Nile by gravity, due to high water levels.

Two main treatment plants are located within the drainage basin of Elmouheet drain: Aburawash and Zenein plants, with maximum effluent of 700,000 and 400,000 m^3/day, respectively. There are minor treatment plants within the drain catchment area.

4.7 East and West Monoufia Drains

This area covers the drains of Monoufia and part of Gharbia Governorates in both western and eastern regions of the Middle Delta. The area is highly important since the flow of the drainage system is dumped into the Rossetta branch in the west and Rayah El Abbassy in the east. The Rossetta branch represents a source for Alexandria drinking water and surroundings, and Rayah El Abbassy is also considered a source of drinking water for a large sector of the Middle Delta.

For this reason NOPWASD is planning 12 treatment plants within this drain system (Tala, Sabal and Shanwan drains in the west and both El Qaranein and El Attfe drains in the east).

4.8 Meet Yazeed Freshwater Canal

Meet Yazeed freshwater canal is one of the most important canals. The canal supplies irrigation water (7.4 mcm/day) to an area of 330,000 feddan, together with drinking water. The canal receives drainage water through the Mehallet Rouh mixing pump station. This drainage water is collected from the catchment area of Mehallet Rouh, Toukh, Tatay, Semetay, Santta and Plai drains. The capacity of the Mehallet Rouh mixing pump station comes mainly from a drainage basin of 70,000 feddan, together with legal and illegal dumping of domestic and industrial wastewater. NOPWASD has included in the national plan four treatment plants for urban communities, two of which are dumping their effluent in the Mehallet Rouh drain system and the other in the Plai drain.

4.9 Bahr El Bagar Drain

Bahr El Bagar drain starts from the Greater Cairo sector, with Belbaise drain in the south and Qalubia drain in the north.

The Bahr El Bagar drain is 106 km long and has two main branches: the 73.2 km Qalubia drain and the 66 km Belbaise drain. The total catchment area of Bahr El Bagar drain system is 760,000 feddan, including 300,000 feddan for Qalubia drain, 60,000 feddan for Belbaise drain and 400,000 feddan for Bahr El Bagar drain downstream from the intersection of the two main branches. The total discharge pumped to Lake Manzala is 1.4 bcm/year.

Bahr El Bagar drain basin is located in a very densely populated area of the Eastern Delta passing through Qalubia, Sharkia and Ismailia Governorates. The water of Bahr El Baqar is used unofficially for irrigation and contributes much to groundwater pollution in the Sharkia Governorate.

All sewage and industrial wastewater, treated and untreated, from the eastern zone of Greater Cairo is dumped into the Belbaise drain through the effluents of both Gabal Asfar and Berka treatment plants. The capacity of Gabal Asfar plant is 1,500,000 m^3/day, while that of the Berka treatment plant is 600,000 m^3/day.

The state of the Qalubia main drain is more serious than the Belbaise drain. Qalubia's main 14 branches (intermediates) collect wastewater treated and untreated legally and illegally from the heavily populated area of Shobra El Kheema and its large industrial area, together with the urban communities of Qalubia and Sharkia Governorates. Because of the good quality of Bahr El Bagar drain with respect to salinity (800 ppm), some mixing pump stations were constructed to cover the shortage of water in canals supplying irrigation water for legal and illegal rice. Rice covers almost 80% of Sharkia Governorate lands in summer. The main mixing pump station on the Qalubia drain is called El Wady, located at the end of the drain, before the connection to Bahr El Bagar drain. This pump station was constructed to supply El Wady canal with 307 mcm/year. El Wady canal has a maximum freshwater discharge of 2.0 mcm/day.

Six treatment plants are operational, and eight plants are planned on both sides of Belbaise drain. Four plants will be on the western side -- two are complete, and the other two are proposed. On the eastern side there are another 4 treatment plants, all of which are complete. The total capacity of the eight plants will be 2,194,000 m^3/day.

On the Bahr El Bagar main drain basin, eight treatment plants are planned, three of which are operational, one of which is complete but not operational, and four of which are proposed. The total capacity of the eight plants will be 93,000 m^3/day.

4.10 Bahr Nashrat Drain

Bahr Nashart drain is one of the main drains in the Middle Delta. The drain has a total length of 71.3 km (Bahr Nashart and extension Upper Nashart drain). The drain basin is located in a highly-populated area, like most Delta drains. The total discharge of No. 8 upper pump station at km 32.25 on Bahr Nashart drain is 235 mcm/year, which is dumped into lake Boroullos and the Mediterranean Sea. There are 10 mixing pump stations downstream from No. 8 Upper Pump Station to cover the shortage of irrigation water in 10 small branch canals as follows:

- El Sath mixing pump station located at km 18 supplies 57,600 m^3/day to El Sath canal.
- Saafaan mixing pump station at km 17 supplies Saafaan canal with 57,600 m^3/day.
- Aleawa mixing pump station at km 14.87 supplies Aleawa canal with 57,600 m^3/day.
- El Sheikh Ibraheim mixing pump station at km 13.25 supplies El Sheikh Ibraheim canal with 57,600 m^3/day of drainage water.
- El Mosharka mixing pump station at km 12.15 supplies El Mosharka canal with 57,600 m^3/day of drainage water.
- Sedy Salem mixing pump station at km 12.5 supplies Sedy Salem canal with 57,600 m^3/day.

- El Ganabia El Sharkeia mixing pump station at km 7.28 supplies El Ganabia El Sharkeia canal with 57,600 m^3/day.
- Gadalla mixing pump station at km 5.402 on the Bahr Nashart main drain supplies the canal with 57,600 m^3/day.
- Gadalla mixing pump station at km 5.3 supplies the canal with 57,600 m^3/day.
- Gadalla mixing pump station at km 2.4 supplies the canal with 57,600 m^3/day.

NOPWASD has included five treatment plants within the drain catchment area, one of which is for Kafr El Ziaat city, where the main center of textile industry is located. The total capacity of the five plants is 170,000 m^3/day.

4.11 Eatai El Baroud Drain

Eatai El Baroud drain flows into El Khandaq El Sharky main canal, which connects finally to Mahmoudia canal, the source of drinking water for Alexandria City. NOPWASD has included one treatment plant for Eatai El Baroud city (now under construction), in order to protect Mahmoudia canal from pollution.

5. Technical Recommendations on WWTP Priorities

5.1 General Recommendations

The following are general recommendations applicable to all projects/areas/drains mentioned in Section 4 of this report. Following these recommendations will speed up the operation of the WWTPs and enhance the quality control of plant effluents to ensure the proper operation of these plants:

- On a case-by-case basis, the situation of the constructed but not yet operating WWTPs needs to be evaluated to rectify any problems and issue the necessary licenses. Priority should be give to plants with a capacity of more than 10,000 m^3/day.

- The required budget for O & M has to be granted on a regular basis to ensure the proper operation over the lifetime of each WWTP. Additionally, the availability of well-trained staff is extremely important to achieve the expected results from the water quality point of view. Another alternative is to involve the private sector in the operation of such plants through the appropriate type of contracts. This approach has been explored by the government and seems promising, especially in desert areas where WWTP effluent could be used to irrigate new lands. Additionally, several demonstration farms are available around the country, providing extension for best practices using domestic wastewater in desert areas. However, selection of areas for wastewater irrigation has to be made with careful consideration of the vulnerability of the groundwater aquifer.

- The quality of WWTP effluent water should be supervised and checked frequently by NOPWASD and MOHP (Ministry of Health and Population) to ensure compliance with law 48/1982.

5.2 Detailed Recommendations

For each of the projects selected under the first two criteria and classified as highest priority, a list of the WWTPs and their status will be presented. Additionally, specific recommendations will be given to improve the water quality status to meet the criteria objectives discussed earlier in the report.

1) El Salam Canal

NOPWASD has proposed 37 plants for the treatment of sanitary drainage wastewater along the main drain of Bahr Hadous and its branch. Additionally, the only operating WWTP in Mansoura City has the capacity of 135,000 m^3/day and dumps its effluent into Mansoura El Qebly drain at km 5.0. Due to the large effluent volume, it is highly recommended that Mansoura WWTP follow the general good practices of O & M. The Mansoura Plant could be a future training center for the staff of Dakahlia, Damietta and Sharkia Governorates. Out of the 37 WWTPs, 18 are already constructed but not yet operational, and 19 are proposed. Action should be taken for construction over a seven-year plan. It is proposed that the construction of these plants be done in three groups, each in three-year programs as follows:

- The first three years would include plants with a capacity of more than 10,000 m^3/day.
- The second three years would comprise WWTPs with a capacity of less than 10,000 m^3/day and which are located downstream from Bahr Hadous drain. This group is important as effluents from these plants will be quite close to the mixing pump station, and will not have sufficient time for natural aeration (natural purification by oxidation).
- The last three years will consider the implementing of all plants having capacity of less than 10,000 m^3/day and located along Bahr Hadous drain and its branches at distances of more than 30 km upstream from the mixing pump station.

The following tables present, in order, the treatment plants included in NOPWASD's plans for the drain system supplying Salam canal.

Bahr Hadous Drain

Operational WTTP

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
1.	Mansoura	13,5000	Mansoura El Qebly	6.8	5.0

WTTPs Constructed but not operating

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
1.	El Gamalia	20,000	El Gawaber	5.200	0.000
2.	El Manzala	20,000	Batteen	11.000	9.300
3.	San El Hagar	10,000	El Qannan	19.200	15.000

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
4.	Dekernis	20,000	Tal Pella	4.300	3.300
5.	Barq El Ezz	20,000	Barq El Ezz	10.800	8.000
6.	Abu Kbeer	20,000	Santrees	6.400	0.000
7.	Aga	10,000	El Mansoura El Mostagad	23.150	20.000
8.	Damas	3,000	Omm Salma	20.300	13.300
9.	Tamy El Madeed	2,000	Tamy El Madeed	5.000	3.000
10.	Awlad Sakr	10,000	Main Bahr Hadous	72.000	52.000
11.	El Sembelaween	20,000	Omm Ghannam	20.840	12.820
12.	Kafr Sakr	10,000	Kofour Negm	8.600	3.300
13.	Kofour Negm	10,000	Kofer Negm	8.600	8.430
14.	Atemeda	10,000	Albouha	9.920	7.000
15.	Koum El Nour	10,000	Koum El Nour	22.500	17.900
16.	Deyarp Negm	10,000	Equa	20.800	1.640
17.	El Kanayat	20,000	Equa	20.800	7.000
18.	Kafer Shokr	10,000	Elwalga	12.100	12.100

19 WWTPs Proposed by NOPWASD

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
1.	Salsabeel	10,000	El Koody	7.500	0.000
2.	El Rabeeia	4000	El Sherka	3.000	0.000
3.	Mehalet Demma	10,000	Radwan	3.700	3.700
4.	Salamoun	3000	Omoum El Heera Aala	24.100	0.000
5.	Bany Ebead	10,000	Tanan	17.710	2.400
6.	Nawas El Gheet	4000	Mansoura El Mostagad	23.150	10.900
7.	Tokh El Karamouh	5000	Omm El Shouk	11.450	6.500
8.	Hehia	10,000	Houd Negeah	8.200	6.000
9.	Sahragt	4000	Sahragt	5.400	2.300
10.	Beshla	4000	Beshla	2.800	2.500
11.	Abou Dawood	3000	El Sembelaween	17.000	2.000
12.	Bany Amer	3000	Al Aareen	20.800	0.000
13.	El Moukataa	3000	Omm Ghannam	20.840	3.000
14.	El Ebrahemia	20,000	El Ebrahemia	32.400	20.000
15.	Meet Ghamr	40000	El Hawaber	19.800	17.500
16.	Awlela	10,000	El Hawaber	19.800	11.680
17.	Dandeet	5000	Dandeet	9.600	8.000
18.	Sahragt El Kobra	2000	Meet Yaeesh	4.850	4.000
19.	Shenbara El Maymona	4000	Bahr Saft El Qebly	55.000	38.000

Lower Serw Drains

NOPWASD has included seven WWTPs in its plans for Lower Serw. Three are constructed already but are waiting for licenses, while the other four are proposed. As mentioned in the general recommendations, it is urgently necessary to evaluate the situation of the three constructed plants (Nasseria, Zarka, and Meniat El Nassr), identify problems facing the operations, and issue the necessary licenses. The following table presents the constructed and proposed WWTPs within the Lower and Upper Serw drains. The table includes locations of the plants, capacity per day, and name of the drain receiving the effluent.

No	**Name**	**Capacity** m^3/day	**Discharging to Drain**	**Discharging Length along Drain** km	**Discharging Location** km
First stage, WWTP constructed but not operating					
1.	El Nasseria	2000	El Harana	12.500	7.250
2.	El Sarka	20,000	El Siala	9.000	8.500
3.	Meniat El Nassr	20,000	Meniat El Nassr	3.500	2.250
Second stage, for priorities of constructing the proposed 4 WWTPs on both Lower and Upper Serw drains					
1.	Kafr El Kordy	3000	El Khordary	5.400	0.000
2.	Bermebal	4000	Bermebal	4.500	2.000
3.	Bedway	3000	Bedway	5.600	0.000
4.	Shaha	4000	New Negeer	6.700	0.000

Farasqour Drain

Farasqour drain is designed to supplement El Salam canal with drainage water, and NOPWASD plans to construct three WWTPs in order to reduce pollution in the drain. Two of the three treatment plants -- Al Horany and El Rawda -- are located along the main Farasqour drain. The third is Farasqour treatment plant, located at the beginning of El Tarha drain. El Tarha drain discharges 128,000 m^3/day to Farasqour main drain at km 4.5.

No	**Name**	**Capacity** m^3/day	**Discharging to Drain**	**Discharging Length along Drain** km	**Discharging Location** km
1.	Farasqour	20,000	El-Tarha	4.800	0.000
2.	Al Horany	2,000	Main Farasqour	11.100	3.500
3.	El Rawda	2,000	Main Farasqour	11.100	10.00

2) El Gharbia Drain

In order to reduce pollution from urban wastewater and industrial wastes in El Gharbia drain, NOPWASD recommends nine WWTPs, as indicated in the following table. The plants are arranged according to need for the reuse.

No	**Name**	**Capacity** m^3/day	**Discharging to Drain**	**Discharging Length along Drain** km	**Discharging Location** km
1.	Mahalla El-Kobra	60,000	Amreia	3.970	0.200
2.	Saft Torab	10,000	Shobra Malkan branch	4.320	2.560
3.	Qottour	10,000	Damatt	9.250	2.250
4.	Mehallet Rouh and Sageen El-Koum	10,000	Old Abshaway	9.900	8.00
5.	Beiala	20,000	Main Gharbia	33.000	21.000
6.	Nabarouh	10,000	Dereen	8.800	7.050
7.	Mahalet Zeiad	20,000	No. 5 East	12.700	8.300

No	Name	Capacity m³/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
8.	Bashbeesh	10,000	Lomana	8.700	2.250
9.	El Hamoul	20,000	El Hamoul	10.300	0.200

3) El Wady and El Mahsama Drains

The tail end of Mahsama drain receives water from three branch drains – Abu Swair, Manaief and El Dabeia – with a catchment area of 25,500 feddan. The main drain also receives legal and illegal wastewater from urban and rural areas. The following table presents the capacities of the three WWTPs along both El Wady and El Mahsama drains and locations and lengths of receiving drains, arranged in order according to the benefit of reducing the pollution of the drains water.

No	Name	Capacity m³/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
A. Operational Plant					
1.	Ismailia	90,000	Mahsama	38.800	4.500
B. CONSTRUCTED AND NOT OPERATIONAL PLANTS					
2.	Tall ElKebeer	10,000	El Wady	23.200	16.000
C. PROPOSED					
3.	El Abbassa	10,000	El Wady	23.200	21.000

4) El Omoum and Edko Drains

El Omoum Drains
For supplying Nobariea canal by drainage water from Shereshra drain (El Omoum drainage Water Reuse Project), three mixing pump stations have been constructed. El Shereshra drain collects drainage water from the extension of El Omoum main drain and from different branch drains.

To improve the drainage water for El Omoum Project in order to comply with law 48, NOPWASD is constructing four WWTPs with an estimated total capacity of 60,000 m^3/day. The following table presents the priority of the four WWTPs in order of priority, based on capacity and site location of the plant with respect to distance from the mixing pump stations.

No	Name	Capacity m³/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
1.	Sedy Eiessa	20,000	Sedy Eiessa	19.000	1.000
2.	Abu Hommous	20,000	Abu Hommous	21.160	7.150
3.	Abu EL-Mattameer	18.000	Tharwat	5.850	5.850
4.	El-Koum EL-Akhdar	2000	Gabaris El-Gharby	22.200	3.750

Specific Recommendations: In order to start operating the three mixing pump stations for the reuse drainage project from El Omoum drain, the following needs to be done:

- Assess the possibility of replacing three potable water treatment plants currently downstream from El Omoum mixing location on the Nobaria canal.
- Other possible sources of drinking water could be deep groundwater from Moghra of Nobaria Sandstone Aquifers, which are available in this area.

Edko Drains
The following table presents the six treatment plants for urban areas included in the Edko drain system.

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
1.	Damanhour (Mensheiet El-Horreia)	160,000	El-Hessa	4.500	3.000
2.	Shebrakheet	9,000	Shebrakheet	NA	NA
3.	Rahmaneia	10,000	Rahmaneia Extension	NA	NA
4.	Mahmoudia	12,000	El-Attfe	23.600	12.000
5.	Besentway	10,000	El-Ghezlan Branch	2.430	0.200
6.	Fazara	2,000	Private drain	Sedy Oqba	1.200

Specific Recommendations: Mahmoudia canal should not be supplied with drainage water mixed with treated sanitary wastewater, since the canal supplies the drinking water for Alexandria city. Irrigation water along the last reach of Mahmoudia canal should be restricted in order to improve the canal flow supplied to Alexandria water treatment plant. Water required for irrigation on both sides of the canal can be compensated by drainage water from Edko drain or from the intermediate drainage system to supply small branch canals. Flow from Edko mixing pump station to Mahmoudia canal must be stopped

5) Qlabsho Project

The Qlabsho project is for reusing 1 bcm/year for horizontal expansion in the northern Delta. NOPWASD has included in its plans seven WWTPs, three on the catchment area of No. 1 lower drain, three on the basin of No. 1 upper drain, and the last one on the basin of No. 2 drain.

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
NO. 1 LOWER DRAIN					
1.	Mohammadia	20,000	Wahdan	4.300	0.000
2.	Kafr Saad	20,000	El-Mashaleb	13.500	6.700
3.	Sherbeen	20,000	Dengway	11.000	7.900
NO. 1 UPPER DRAIN					
1.	Battra	20,000	Battra Al-Qebly	6.300	4.750
2.	Talkha	20,000	No. 1 Upper	NA	26.100
3.	Meet El Korba	20,000	Meet Assas	NA	NA
NO. 2 DRAIN					
1.	Belkass	20,000	Belkass	2.700	2.700

Specific Recommendations: Gammasa weir is constructed downstream from the drainage pump station of No. 1 lower drain in order to raise the water level for the mixing pump station. High water levels at the end of the drain system will certainly affect levels of groundwater in the old lands, which will have a negative impact on their production.

6) El Mouheet Drain

Most pollution of the drain is coming from two large treatment plants collecting the sewage wastewater of the eastern part of greater Cairo (Giza City and surroundings). The following table presents the constructed and proposed treatment plants on Elmouheet drain and its branches.

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
1.	Abu Rawash	700,000 max 500,000 min	Barakat	4.300	1.800
2.	Zenein	400,000 max 280,000 min	Nahia El Sharky	6.200	5.500
3.	Menshaat El Kanater	10,000	Omm Deenar	5.420	2.600
4.	Tohormous	10,000	El Mansouria El Sharky	7.400	2.500
5.	El Hawamdia	20,000	Sakkara	12.600	2.000
6.	El Badrasheen (proposed)	20,000	Elmouheet	70.200	48.740

Specific Recommendations:

- Elmouheet drain receives a large discharge of treated sanitary wastewater, estimated at 1.2 mcm/day and dumped into the Nile (Rossetta Branch). Even when the dumping effluent is treated and complies with law 48, it is a great source of pollution for the river.
- Effluent of Abu Rawash treatment plant could be used in the desert area around the plant for forestry or cotton.
- Effluent of Zenein treatment plant should be directed to Abu Rawash desert through Nahia El Sharky drain and Gannabiet Elmouheet drain Al Yousra, and then be pumped into the desert to be used in forestry.
- Elmouheet drain flow should also be pumped from a suitable site to the desert west of Alexandria Road, to be used for cotton crops or forestry. This part of the desert is quite far from the shallow aquifer of the groundwater and is not connected to the Delta or the Nile Valley groundwater reservoir.

7) Monoufia Governorate Drains

For the Western Region

NOWPASD has included eight WWTPs in its plans for Monoufia, five within the Sabal drain basin and three within the Tala catchment area.

No	Name	Capacity m^3/day	Discharging to Drain	Dischargin g Length along Drain km	Discharging Location km
I)	Sabal Basin				
1.	Shamma and Tahway	10,000	Monshaat Gorass	3.150	0.000
2.	Ashmoun	20,000	Sabal	47.200	33.000
3.	Samadoun	10,000	Ashmoun	19.000	0.000
4.	Talia	10,000	Ashmoun	19.000	6.000
5.	Senttrees	10,000	Sobk	16.750	0.500
II)	Tala Basin				
1.	Al Shohada	20,000	Salamoun	3.350	3.350
2.	Tala	20,000	Tala	39.500	29.770
3.	Al Batanoun	20,000	Shebeen El Koum	4.060	0.600

For the Eastern Region

The eastern region of Monoufia Governorate is covered by El-Qaranein and El-Attfe drainage system. To avoid dumping untreated wastewater into drains of heavily populated areas of Monoufia and Gharbia Governorates, NOPWASD has included in its plans four treatment plants, as presented in the following table.

No	Name	Capacity m^3/day	Discharging to Drain	Dischargin g Length along Drain km	Discharging Location km
El Qaranein Basin					
1.	El-Santa	20,000	El-Qaranein	43.500	9.725
El-Attfe Basin					
2.	Quesna	10,000	Estanha	8.300	5.330
3.	Zefta	20,000	Masguid Wasseif	22.000	5.700
4.	Meet Boura	10,000	Masguid Wasseif	22.000	19.400

Specific Recommendations:

- In order to minimize the flow at drainage pump stations (Sabal, Tala and East of Monoufia), the drainage water should be harvested from the intermediate drain to supply branch canals with irrigation water. Canals with drinking water compact units should be excluded.
- Drainage water flow left at the three pump stations should be diverted and not dumped to either Rossetta Branch or Rayah Al-Abbassy.

8) Meet Yazeed Freshwater Canal

NOWPASD has included in the national plan four treatment plants for urban communities in Meet Yazeed. Two are dumping effluent in Mehallet Rouh drain system and the other in Plai drain.

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
1.	Berket El Sabae	20,000	Mehallet Rouh	35.000	31.860
2.	Ganzour	10,000	Meet Faris	9.000	1.200
3.	Qourasheia and Meet Yazeed	10,000	Plai	15.000	4.840
4.	Shenrak	2,000	Plai	15.000	9.200

Specific Recommendations: Following the policy of no drainage dumping into mixing pump stations in canals which are a source of drinking water, the following recommendations should be considered:

- Reduce pumped flow to Meet Yazeed canal by harvesting drainage water from intermediate drains near mixing pump stations to supply the small branch canals.
- The remaining flow should not be pumped into Meet Yazeed canal, so as to avoid polluting the canal water.

9) Bahr El Bagar

NOPWASD plans 46 treatment plants, together with Gabal Asfar and Berka treatment plants, for the Bahr El Bagar. For Qalubia drain basin, 31 treatment plants are planned. On the western side there will be 13 treatment plants. Four are constructed but not operating, and nine are proposed. On the eastern side, there will be 18 treatment plants: six are constructed but not operating, and 12 are proposed. The following table presents treatment plants according to NOPWASD plans, including capacity, whether the plant is constructed, operating or proposed, receiving drains, and locations.

No	Name	Capacity m^3/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
QALUBIA DRAIN BASIN, WESTERN SIDE					
I) Constructed and Operational					
1.	Zagazig Plants	60,000	El Aslogy	7.750	8.000
II) Constructed and not Operational					
2.	Zankaloon	20,000	Zankaloon	7.730	3.300
3.	Menia El Qamh	20,000	Menia El Qamh	6.150	6.000
4.	Banha	70,000	Al Mazraa	6.000	6.000
III) Proposed					
5.	Meet Bashar	4,000	Meet Rabea	5.560	5.560
6.	El Shammout	10,000	El Shammout	3.000	2.500
7.	Al Ramla	6,000	Al Ramla	1.620	1.600
8.	Beltan	8,000	Magoul	3.740	3.400
9.	Degway	5,000	Tahla	25.400	14.000
10.	Al Amar	10,000	Tahla	25.400	15.000
11.	Tant El Gezera	5,000	Tahla	25.400	16.000
12.	Aghour	10,000	Aghour	7.500	5.000
13.	Qarnavill	5,000	Qarnavill	3.400	2.000
EASTERN SIDE					
I) Constructed and not Operational					
1.	Enshass El Raml	10,000	Al Gawsaq El Gharby	16.900	14.500

No	Name	Capacity m³/day	Discharging to Drain	Discharging Length along Drain km	Discharging Location km
2.	Meet Kanana	2,000	Meet Kanana	3.200	1.300
3.	Toukh	16,000	Kalubia	73.150	57.200
4.	Belqase	6,000	Shebeen El Kanater	32.080	25.400
5.	Qaha	10,000	Kalubia	73.150	67.000
6.	Qalyoub & Kanater	140,000	Sandebeese	13.400	9.200
II) Proposed					
7.	Ahraz	5,000	Ahraz	11.300	10.000
8.	Marsafa	10,000	Marsafa	4.000	3.000
9.	Moshtohor	15,000	Manzala	4.420	1.000
10.	Kafr Shebeen	8,000	Shebeen El Kanater	32.080	25.400
11.	Alqousheish	20,000	Alqousheish	3.510	2.000
12.	Nai	4,000	Noway	14.900	11.000
13.	Tanan	15,000	Tanan	10.500	8.000
14.	Meet Halfa	20,000	Namoul	20.250	19.000
15.	Sendion	10,000	Escandar	15.600	5.000
16.	El Bradaa	15,000	Sendbeese	13.400	2.500
17.	Abu Elgheet	2,000	Sendbeese	13.400	2.500
18.	Shalaqan	5,000	Kanater Khaireia	10.200	9.200
BELBAISE DRAIN BASIN EASTERN SIDE					
Constructed and Operational					
1.	Gabal Asfar and Berka	2,100,000	Gabal Asfar	13.200	7.300
2.	El Khanka	18,000	Gabal Asfar	13.200	13.750
Constructed and not Operational					
3.	Seriaqous	10,000	Belbaise	66.000	57.500
4.	Mashtool El Souq	10,000	El Anaber	3.000	0.000
WESTERN SIDE					
I) Constructed and not Operational					
5.	Belbaise	20,000	Belbaise	66.000	17.000
6.	Shebeen El Kanater	18,000	Belbaise	66.000	47.000
II) Proposed					
7.	Arab Al Aleeqat	8,000	Belbaise	66.000	45.500
8.	Kafr Abeeyan	10,000	Belbaise	66.000	51.000
BAHR BAGAR BASIN EASTERN SIDE					
I) Constructed and Operational					
1.	Al Qourane	20,000	Al Azzazy	8.540	4.200
2.	Abu Hammad	20,000	Al Azzazy	8.540	1.750
3.	Fakous	20,000	Bahr Bagar	106.000	72.000
II) Proposed					
4.	Salhia	6,000	Qahyouna	9.640	8.50
5.	Akiad Bahria	4,000	El Seada	7.400	5.000
6.	Akiad Qeblia	3,000	El Seada	7.400	5.500
WESTERN SIDE					
I) Constructed and not Operational					
7.	El Hesenia	10,000	Bahr Bagar	106.000	52.000
II) Proposed					
8.	Sauod	10,000	Bahr Bagar	106.000	52.000

Specific Recommendations: It is not advisable to convey the large flow of treated and untreated effluent of Gabal Asfar and Berka plants (2,100,000 m^3/day) along a distance of more than 170 km through the highly populated region of the eastern Delta. This would encourage illegal use of the drainage water in Belbaise, Kalubia and Bahr Bagar drains. For this reason, effluents of those two large treatment plants should be used locally in forestry or expansion of cotton cultivation in Gabal Asfar Desert near the treatment plants.

10) Bahr Nashart Drain

NOPWASD has included in its plan five treatment plants, one of which is already constructed and operating, and four of which are proposed.

No	**Name**	**Capacity** m^3/day	**Discharging to Drain**	**Discharging Length along Drain** km	**Discharging Location** km
	Constructed and Operating				
1.	Kafr El Ziaat	120,000	Gonaah	32.500	32.000
B)	Proposed				
2.	Basioun	20,000	Gonaah	32.500	18.400
3.	Quellein	10,000	Upper Nashart	NA	10.000
4.	Mahallet Marhoum	10,000	Shouber (ext.)	4.200	2.400
5.	Berma	2,000	Upper Nashart	NA	35.730

11) Eatai El Baroud drain

NOPWASD has constructed a 10,000 m^3/day treatment plant for Eatai El Baroud city. The plant is located on the left bank of Eatai El Baroud main drain at km 11, which is the same distance to the pumping station delivering water to El Khandag El Sharky canal.

Specific Recommendations: In order to protect Mahmoudia canal from pollution, it is advisable to take action for the following:

- No industrial wastewater should be dumped in Eatai El Baroud main drain and its branches, unless it is properly treated as per Law 48.
- Intermediate reuse for the drain branches should be applied in order to reduce the flow reaching Eatai El Baroud drainage pump station.
- The remaining flow reaching the pump station should be treated or diverted to a nearby drain that is not used for mixing.

6. Budget Analysis of WWTP Development

Table 2 below gives the analysis of the WWTP construction budgets. For each drain in the priority areas, estimated total cost for WWTP construction is presented along with construction starting date, current status, expenditure by the end of the fiscal year 98/99 and financial allocation for 2000. All estimates and analysis are based on NOPWASD's five-year work plans for 1997-2002 and 2002-2007.

Table 2 also presents summary budget estimates required to complete the construction of WWTPs for MWRI's highest priority areas in the Nile Delta. The total cost to treat around 2 bcm/year of wastewater was estimated at 7.4 billion L.E. The expenditure till the end of 98/99 was 5.1 billion with less than 2.0 billion L.E. remaining, based on current financial allocations for the year 99/00.

The situation is rather encouraging. However, one should also consider the expenses needed to apply other specific recommendations for each project. The O&M costs and the need for continuous training, in addition to rehabilitation and replacement of old WWTPs, must also be considered. Similar exercises should be carried out for the entire nation to come up with a budget needed for the whole country, so that decisions on budget allocation can be realistic.

7. Summary and Conclusions

MWRI has been charged with devising policies for improved management of discharge and reuse of urban wastewater in agricultural drains. MWRI has identified 11 main areas within the Nile Delta that are considered highest priority in terms of protecting the health of people in contact with water and promoting sustainable drainage water irrigation for agriculture. The following recommendations are designed to help MWRI and Egypt combat further degradation of the region's drainage water.

- On a case-by-case basis, the WTTPs which are completed but not yet operational must be investigated and operations begun immediately.
- The required budget for O & M has to be granted on a regular basis to ensure the proper operation over the lifetime of the WWTPs. A well-trained staff is crucial to achieving expected water quality results.
- The quality of WWTP effluents should be supervised and checked frequently by NOPWASD and MOHP to ensure compliance with law 48/1982. The drain water quality must be monitored to assess the impact of WWTP operations on water quality and the water's suitability for various uses.
- Involvement of the private sector in the operation of WWTPs through the appropriate type of contract should be investigated. This approach might be promising especially in desert areas where WWTP effluent could be used directly to irrigate new lands. Selection of areas for wastewater irrigation has to carefully consider the vulnerability of the groundwater aquifer to avoid groundwater pollution.
- Construction and operation of the listed WWTPs will only partially solve the problem, as many small communities will continue to dump raw sewage to these drains. Public awareness of the extent of water quality problems and the urgent need to protect valuable water resources is essential for any pollution abatement plan to work. Farmers should be taught that not all drainage water is suitable for all crops and that violation of laws could be detrimental to the health of their families.
- There is a great need for reliable data on water quality in Egypt. The current effort by the National Water Research Center to build a national water quality-monitoring network should be encouraged. The network will cover the Nile and irrigation and drainage systems, and will link to the current groundwater monitoring network. Having data from this network will enable the GOE to evaluate the quality of the country's water resources and assess the impact of WWTPs on water quality and its availability for different uses. Data sharing among various water stakeholders has to be encouraged at the highest level.

- Recently, there has been a governmental budget crunch that is not expected to end soon. Yet, the use of any polluted water has to be stopped immediately. Future development in the Nile Delta might be hindered due to water quality deterioration, unless serious actions are taken in a comprehensive and strategic sense.